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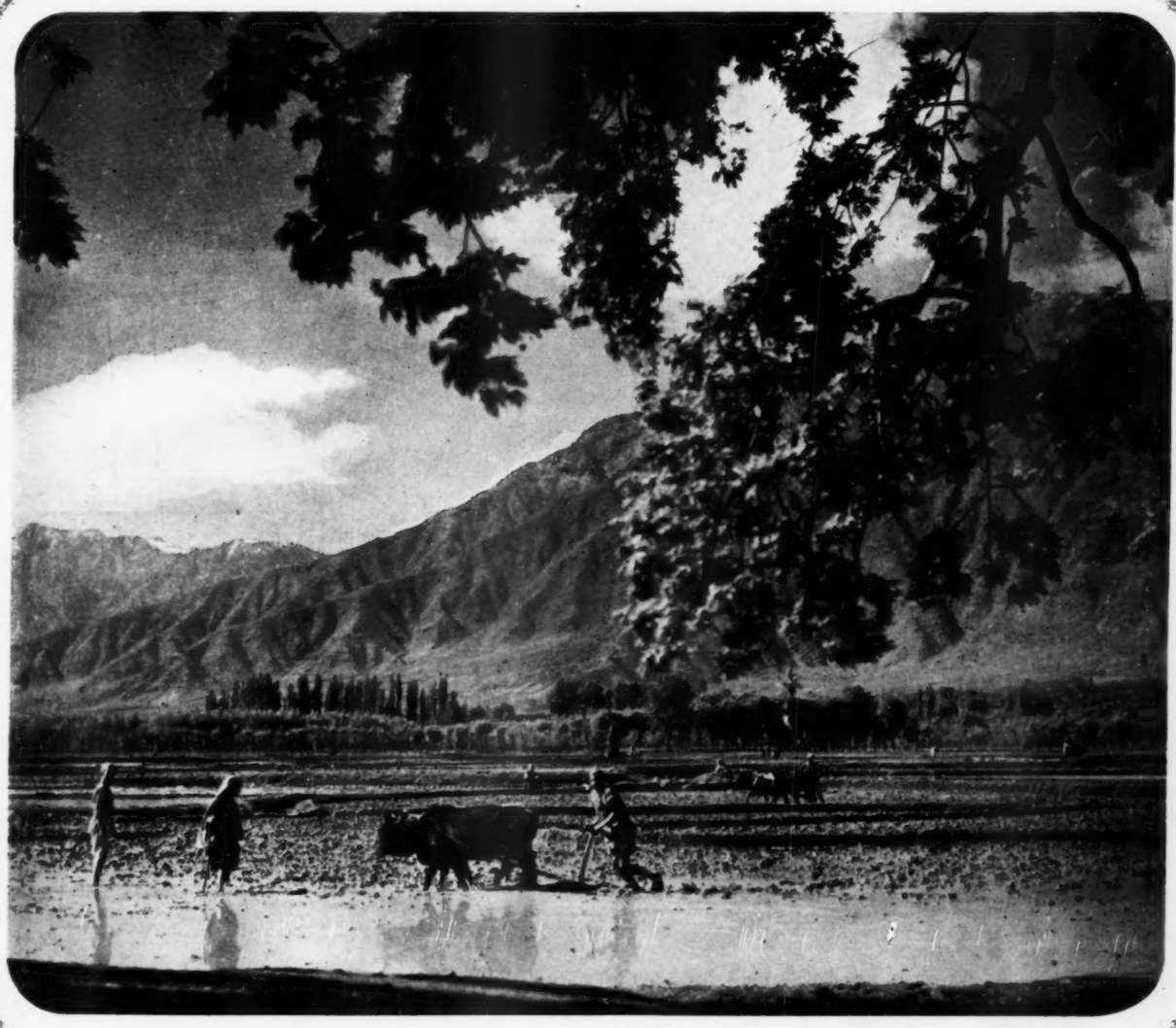

VOLUME 2, NO. 1 JANUARY 1950

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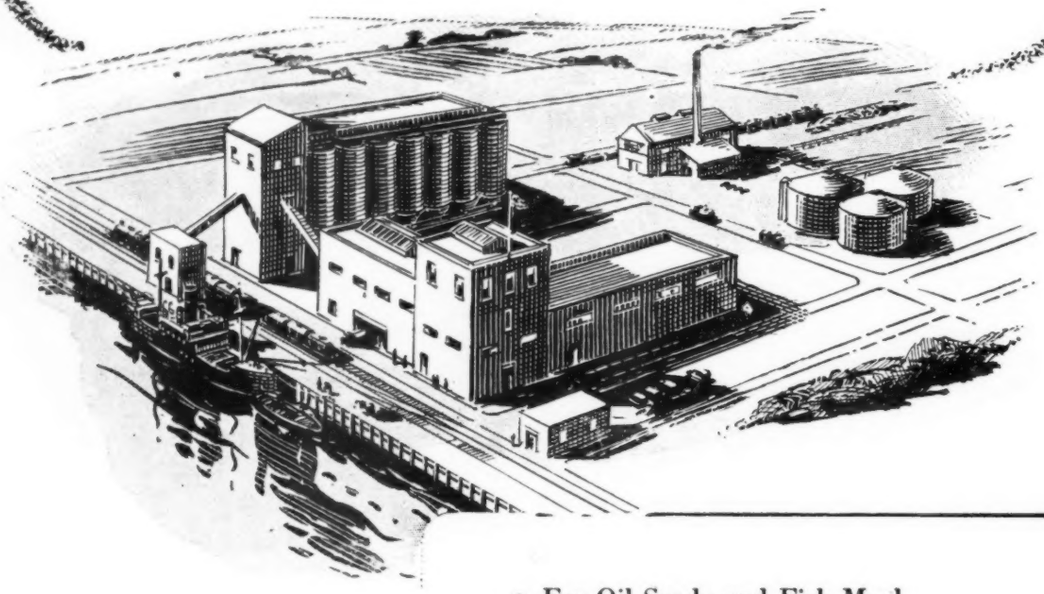

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THIS MONTH'S COVER

A fine study of peasants at work in the ricefields of Kashmir, near the foot of the Himalayas. This territory is at the moment the subject of dispute in the United Nations Assembly. As a Princely State it acceded to India in 1947, but due to its large Muslim majority it is being claimed by Pakistan. The temperate climate makes conditions ideal for the raising of cereal crops and fruit.

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Editorial Comment

Groundnut aftermath

AFTER the debate on the East African Groundnut Scheme on November 21 the House of Commons decisively rejected by 315 to 161 votes the amendment to the effect that the Overseas Food Corporation's work in East Africa should be made the subject of a full enquiry, and adopted the Government's resolution that the report of the Corporation should be taken note of. Nevertheless, it is permissible to speculate whether the last has really been heard of the matter.

In his opening speech Mr. Strachey, the Minister of Food, indicated, it is true, that the original target of the scheme had been sensibly modified; there is to be no further clearance at Kongwa, but it is proposed to extend clearances at Urambo to 70,000 acres. In the Southern Highlands it is proposed to clear and plant an additional 2,000 acres for the crop of 1950, 20,000 acres in 1951 and to work up to a target of 600,000 acres by 1954. Mr. Strachey appeared to regard the relatively limited targets for 1950 and 1951 as being in the nature of a pilot scheme, but as apparently the fixed intention is to aim at a target of 600,000 acres in 1954 in any event, and as, moreover, heavy expenditure on railways, ports and pipelines have already been incurred in anticipation of the ultimate expansion to this acreage or a larger figure, it is somewhat difficult to see how the description of a pilot scheme can be applied to the 1950 and 1951 operations inasmuch as by definition a pilot scheme implies that, should it not give satisfactory results, further developments on those lines will be abandoned.

In any event, it was clear from the outset that when the scheme was originally formulated the establishment of Government-owned and operated plantations was to be regarded only as a temporary measure necessitated by the immediate urgency of the situation, and that the ultimate intention was that it should develop into a scheme in which African cultivators would participate. There has so far been no indication as to the lines which such developments could suitably take; to us it seems obvious that there is somewhat urgent need that these objectives should be defined and that the methods and agricultural systems which can best be followed to achieve this undeniably desirable object should be critically examined by a body of persons without political affiliations qualified to undertake the task.

There is a large body of people with the necessary scientific, agricultural and administrative qualifications and experience to undertake the task, and to us it seems that, leaving political considerations aside, it is merely a matter of common sense to take advantage of this to take stock of the position.

To our mind it is indeed tragic that a matter which is so pregnant with possibilities for good and evil for millions of people in Africa and which can so profoundly affect the reputation and the prestige of the British nation should become a political party issue. That it has so become is indeed apparent from the numerous party recriminations and allusions which were so painfully in evidence during the debate.

Rice and grass

THE expansion of rice cultivation in the Western Hemisphere, employing large-scale farming methods, has been one of the more remarkable developments which have occurred during and since the war. Particularly has this been the case in the Southern states of the U.S.A. and in California.

An interesting feature is that of late years a rotation comprising grass and seeded pasture has become extensively adopted in the Rice Belt in Louisiana and Texas, based on experimental work carried out by W. B. Sturgess and R. K. Walker at the Louisiana Agricultural Experiment Station.

The rotation comprises one year under rice, followed by two years under grass; after the rice crop the lands are drained, disced and harrowed and a dressing of phosphate applied, after which the ley is seeded down, the seed mixture including white clover, white Dutch clover and Lespedeza. Bermuda grass, carpet grass and similar species usually appear as volunteers in the ley.

It is stated that under this system it has been possible greatly to increase the rate of stocking, while rice yields are also much increased. A case has been cited of a farm which previously carried 60 mature cows having its carrying capacity raised to 120 cows with accompanying increases in the rice yield of 75 to 100%, and without extension of the cultivated area.

In the rice-growing districts in the Lombardy Plain of Northern Italy a comparable system has existed for the last 70 years; the rotation sequence is somewhat different and comprises three or four years under rice, followed by a year under a dry crop, usually maize or pulses, followed by two years under planted grass, the essential feature being the integration of rice growing with animal husbandry and dairying. Under this system the rice yields recorded are among the highest in the world, while the introduction of dairying in the rotation has been of great economic benefit.

It is true that these developments apply to subtropical or semi-temperate regions, and we are without direct evidence as to how far they may be

capable of application under fully tropical conditions, but they do indicate that extensive experiment might be well worth while, particularly in connection with the large-scale experimental work on the mechanisation of rice which is in progress in several countries.

The advantages of a rotation of a grass ley with dry cereals is now in principle accepted widely and its extension to include rice, thereby enabling animal husbandry to be incorporated into a rice economy under tropical conditions, may hold out great possibilities.

It is uncertain how far this would be practical politics in unregulated peasant agriculture, although even here controlled rotation of rice with sugar cane, pulses and dry grains on communally-owned peasant lands has long been a feature of the system devised many years ago by the Dutch in Java, while in North Malaya cattle and buffaloes are pastured in rice fields during the interval between two crops. On the other hand, the introduction of large-scale mechanisation on extensive areas with its concomitant of complete control over water supplies through irrigation and rainage may offer opportunities for the trial of the method on a sufficiently large scale to enable safe deductions to be drawn and accordingly seems well worth while.

The ultra-organic school

JUST which is the best way to grow a crop has, no doubt, been a matter of dispute and difference from the time man began to produce his food as well as hunt for it. Discussion and controversy are the very agents of progress. Nevertheless, there are times when some controversies would seem to have outstayed their welcome and outlived their usefulness, and this surely is the case with the extremist views of the so-called organic agricultural school. The 1949 meeting of the British Association had scarcely refocused public attention upon the world food and population problem when letters from members of this school began to appear in the Press condemning the very means by which Sir John Russell and other scientists had suggested we might avert a future Malthusian crisis.

It would seem that all we have to do to grow perfect crops is to limit the assistance we give our soils and plants to the provision of entirely organic manures. Seed dressings, insecticides, fungicides, all these are unnecessary; for the purely organic system of nutrition will gradually confer upon our crops an almost complete immunity. These sweeping claims are made with an assurance that would ill become the true scientist, but it is, unfortunately, true to say that many people are likely to be misled by this superficial atmosphere of conviction. It has sometimes been suggested that it is better to ignore these outbursts, since counteractions merely give greater publicity to the extremists. This is the point of view of a diplomat who knows that he is in the wrong; it is a ridiculous policy for those who are in the right.

The complete reply to the organic thesis is both lengthy and technical, and it can never be expressed in prose as vivid and colourful as that of the popular ' all-humus ' books and articles. Extremism and rhetoric go together; logic and orthodoxy require more sober words and phrases. The layman who is not technically minded is unlikely to plough through a long vindication of scientific agricultural methods with durable enthusiasm. But short replies, pinning the organic extremists down upon their own ground, should and must be made. And for these tasks there is abundant material.

It is claimed that immunity to disease is attained when plant nutrition is based upon organic manures. Why, then, were the worst ravages of potato blight experienced in the hungry forties of the last century ? The Irish potato crops were grown upon manures at that time ; fertilisers were in their infancy, and they had certainly not crossed the Irish Sea in 1840. It is claimed that pests, including insects of which plants are the natural food, do not simultaneously attack those that are raised by organic methods; it is also claimed that such plants are far more nutritious as food for man and his animals. There is surely a paradox here that demands rational explanation. How odd and convenient that the same material which is less palatable to one class of consumer should be more palatable to the desired consumers ! It is worth noting that only one of the leading advocates of organic cropping has attempted to resolve this dilemma and the ingenious argument then presented was that insect pests were so quickly satisfied in their invasions of the organic-fed crop that the damage caused was inappreciable.

The words ' organic ' and ' biological ' are invested with almost sacred righteousness, while the word ' chemical ' is treated as if it were itself an accusation. Yet every green plant is the very bridge between the inorganic and organic world. Plants live by the assimilation of simple inorganic ions and by the photosynthesis of carbon from the air's carbon dioxide; and these ingredients are built up into complex organic molecules which then support higher forms of life. Who, realising this, can presume to distinguish disparagingly between a class of plant food that is ' organic ' and another class that is ' chemical ' ? This school of thought has frequently denounced field and plot tests on the grounds that only a part of the total process of plant growth is studied. Could any doctrine be more open to the charge that a part is mistaken for the whole than this dogmatic opinion that all crops should be exclusively grown upon organic forms of food ? This controversy is almost as obsolete as the Phlogiston theory of combustion and it should be exposed more vigorously.

Consider the ant

IN Proverbs VI. 6, we, or at least the less energetic amongst us, are enjoined to consider the ways of the ant and thereby acquire wisdom. This sage advice has come down to us through the ages; indeed, as time progresses and knowledge extends, its applicability to human affairs, especially in their agricultural aspects, becomes more and more evident. For there are ants and ants, and while some show a pleasing willingness to accommodate themselves to human ends and aims, others, it must be admitted, are distinctly non-co-operative and even hostile. There appear to be, in fact, differences of conduct and of viewpoint among ant communities of different genera which parallel to an extent the acute divergences, especially on political and administrative matters, which make human existence at the present stage such a precarious and nerve-racking thing.

It therefore behoves the agriculturist and the entomologist to examine with care the ways of the ant and, while encouraging by all possible means those which evince (from the cultivator's point of view) the proper co-operative spirit, sternly to endeavour to repress the subversive activities of those with alien aims.

The latest example comes from the Solomon Islands, where, for many years before the last war, premature nutfall on coconut plantations, caused by the attacks of a coreid bug (*Amblypelta cocophaga*), was a serious source of loss. Pre-war scientific workers had indeed shown that wherever a certain yellow tree ant with the somewhat formidable name of *Oecophylla smaradigna subnitida* was well established on coconut palms nutfall did not occur, since the ant destroyed or drove off the bug. Alas, however, the beneficent influence of *Oecophylla* was counteracted by the activities of two other ants rejoicing in the names of *Pheidole oceanica* and *Iridomyrme myrmecodiae*, which drove out *Oecophylla* and left the maleficent *Amblypelta* free to continue its nefarious depredations.

It was the practice before the war to keep the coconut plantations very clean, cattle being grazed under the palms, while fallen fronds, etc., were collected and burnt. During the war period cultivation perforce was suspended, the plantations became overgrown with undergrowth and fallen palm fronds and debris accumulated. When it became possible to resume work on the plantations it was, surprisingly enough, evident that a great change had taken place and that large areas which previously had been severely affected by nutfall were bearing normal crops.

The explanation appeared to be that under the altered conditions the beneficent *Oecophylla* had once more been able to reassert itself and to circumvent the hostile *Pheidole*, which, incidentally, has the habit of building its nest at the base of coconut palms.

Under clean conditions *Pheidole*, lying in ambush at the foot of the trees, was able to overwhelm and exterminate *Oecophylla* as they ascended or descended trees, but when undergrowth and plant debris accumulated it provided alternative routes whereby *Oecophylla* could reach the crowns of the palms to pursue their beneficent activities without interference from their natural enemies.

These observations recently recorded by Messrs. R. Leach and B. A. O'Connor aptly illustrate the divergent activities of different sections of the ant population and show how materially rewarding may be their study.

Indeed, there are at least indications that similar studies might produce comparable results, for example, in connection with the Swollen Shoot cocoa disease in West Africa or the Sudden Death disease of cloves in Zanzibar inasmuch as the vectors and suspected vectors of these two maladies are known to be transported and tended by the indefatigable ant for purposes of their own. On this account the advice of King Solomon to consider the ant seems to be more than ever appropriate, although not, perhaps, entirely in the sense which its original author intended.

Compost from sewage and refuse

THERE is growing appreciation of the simplicity and flexibility of the well-known Indore process of composting for the disposal of waste products. To exemplify this we would refer to the article by Mr. F. C. Cooke on his experience in composting in a Japanese internment camp, to a review of Mr. van Vuren's book on his pioneer work on municipal composting in South Africa and to a review of two pamphlets recently published by the Albert Howard Foundation of Organic Husbandry, all of which appear in this issue of WORLD CROPS.

The hygienic disposal of refuse offers little difficulty; after sorting, it may be pulverised, in which form it may be applied to the land, or it may be composted with sewage or sludge from sewage works. Of the end products of sewage treatment the sludge is the most difficult to handle. After treatment it may be dried and pulverised, when it is safe and convenient for agricultural purposes, or it may be composted with garbage. The resultant compost is an odourless, friable material which usually finds a ready sale among farmers and horticulturists. It is claimed that the composting of refuse with sludge or sewage is the ideal way of handling urban waste. Certainly it is more satisfactory and safer than dumping, incinerating or consigning to the sea. Furthermore, under proper control there is no danger to health, either during the preparation or in its use on the land.

The quality of compost is so variable that there is difficulty in selling it on a basis of stable chemical composition and this must be counterbalanced by offering it at an attractive price. Municipal authorities should not expect a profit on composting; their proper attitude should be to bring about a reduction in the cost of night soil and garbage disposal, and it is essential that the cost of production be low. Handling must therefore be reduced to a minimum and the whole process mechanised as far as possible.

Much has been written regarding the place that compost should take in agriculture and it is easy to over-emphasise its value. In the tropics, for instance, the oxidation of organic matter in the soil is so rapid that green manuring may be, under suitable conditions, equally as effective as compost. On the other hand, the effect on growth of artificials in the presence of adequate humus in the soil is frequently most striking. There can be no question that humus deficiency is very apparent and widespread, and if we are to avoid the errors of the past, the maintenance of humus in the soil is essential. We must therefore consider the value of compost not merely in respect of its content of nitrogen, phosphates and potash, but also on its content of humus.

Compost is not a substitute for costly sewage schemes, but it is claimed that it can be prepared at existing sewage works with financial advantage to the municipality and benefit to agriculture. It may well be that eventually the preparation of compost from refuse and sewage will become normal procedure.

Fertilisers plus 2:4—D

THE enormous and rapid expansion of growth-regulating substances for selective weed control is one of the most striking advances in post-war agriculture. Those who study American literature will certainly be well aware of 2:4—D (or 2:4-dichlorophenoxy-acetic acid) which has jumped into the ' big business ' class in the United States more quickly than any other agricultural chemical. In Britain and some other countries, 2:4—D is known as D.C.P.A., and there is also considerable development of a very similar weed-killing hormone, 2-methyl-4-chlorophenoxy-acetic acid, known as M.C.P.A. In general, with these two weed-killers and one or two other similar organic substances very small quantities per acre are required for the control of many classes of weeds and fortunately a few major crops are more or less immune at these low rates of application. In particular, cereal crops and the grasses are immune.

A new development being fostered by U.S. Department of Agriculture research is the mixing of fertilisers and 2:4—D. To the arable farmer this idea may seem rather pointless for his main fertiliser dressings are applied to seed-beds and 2:4—D is a post-emergence weed-killer. But the grassland farmer has a crop that is growing at all times and which is always associated with weeds, and, in general, fertiliser dressings to grassland are broadcast top-dressings. In theory, therefore, the joint application of 2:4—D and a fertiliser is practicable where the primary aim is to encourage the growth of the grasses and legumes are not an important component of the sward. Even so, therefore the use of such a mixture would be confined to grassland areas when the tilling or checking of the legumes was not bad husbandry and there would be many areas suitable for this combined treatment. The first big question for research was whether 2:4—D would lose any of its weed-killing properties through being mixed with fertiliser materials. It must be remembered that fertiliser mixtures often have to be stored for long periods and temperatures and moisture contents of fertiliser heaps frequently vary during storage. 0.5% of 2:4—D was incorporated in a compound fertiliser and the mixture was stored for various periods and under various moisture and temperature conditions. The result was emphatic. 2:4—D lost none of its potency even after ten months' storage as a minor ingredient in chemical fertiliser.

Next came field tests. At 600 lb. of fertiliser per acre, the 0.5% of 2:4—D supplied 3 lb. per acre for weed killing. Grassland badly infested with weeds was chosen for the test. The fertiliser dressing was also applied without the 2:4—D as a component. In both sets of plots the fertiliser treatment greatly stimulated grass growth in the spring and the autumn. But where no 2:4—D had been included the weeds also profited and cuttings of the subsequent growth showed rather more than 50% by weight of weed vegetation; where 2:4—D had been included, the similar figure was only 1.5% or less for some plots.

The advantages of this new method of applying 2:4—D are obvious. One operation instead of two; and the diluent that would be needed for a separate 2:4—D dressing is saved since it is the fertiliser which becomes the diluent. Wherever more grass is wanted, and under conditions where legumes do not make a large contribution to the production, this idea may be worth considering. There are, however, disadvantages. To apply the correct amount of 2:4—D per acre, a fixed amount of fertiliser would have to be given; farmers who vary the size of their fertiliser dressings might use too much or too little 2:4—D. There is also the risk of error—with bags of 2:4—D fertiliser being used for non-immune arable crops. Manufacturers might have to guard against this hazard by using bags with a distinguishing colour, or carrying warnings in large non-fading print. However, these are difficulties that are fairly easy to overcome.

World Cereals Today

MAIZE

The Highest Yielding Cereal

E. S. BUNTING, B.Sc. (Lond.)

Department of Agriculture, Oxford University

Of all the cereals maize is capable of giving the highest yields, and accordingly is of great potential importance in a world of rapidly growing population. Chiefly grown in the U.S.A., where its principal use is feeding livestock, it is also widely grown in many other countries, in some of which it is the staple food.

Of late years the introduction of hybrid seed has greatly increased yields, and opens up possibilities of more extended production.

MAIZE (*Zea Mays*), the tallest and most productive of all cereal crops, exists only under cultivation. No wild or uncultivated maize is known amongst present or ancestral types and its origin remains a matter for speculation. Since some related genera are native to Asia it has been argued that maize, also, may be of Asiatic origin. However, there is no evidence that maize was known in Asia until after the discovery of America and the present controversy centres around two main theories, each of which postulate an American origin. The first theory attaches great importance to the genus *Euchlaena* (teosinte). Teosinte, the closest wild relative of maize, is native to southern Mexico and Guatemala where it is found as a common weed of maize fields. Teosinte readily crosses with maize and the origin of maize from teosinte has been variously attributed to direct selection by man, to large-scale mutations, or to the hybridisation of teosinte and a wild grass. The other main theory is that maize arose from a wild pod corn — pod corns, in addition to the husk covering the entire ear, have husk-like structures enclosing each separate kernel.

Evolution of the maize plant

The dramatic discovery in 1948 of maize remains in Mexico, which are conservatively estimated to be over 3,000 years' old, weights the scales heavily in favour of the pod corn theory, because the oldest maizes found are of the pod corn type. The present explanation for the close relationship between teosinte and maize, based on genetical and cytological investigations, is that teosinte arose as a result of the crossing of maize with a wild grass. The Mexican finds support this view, since maizes with teosinte-like characters are of more recent date than the pod corn maizes. If the development of maize from a wild pod corn is accepted it seems probable that maize originated in South America, in which case Central America (Mexico and Guatemala)—considered to be the centre of origin by advocates of the 'teosinte' hypothesis—

would be a secondary centre of varietal diversity.

The history of maize

Maize was the foundation of the Inca, the Maya and the Aztec civilisations. It has retained its position as the most important American crop until the present day and in many ways the history of maize is the history of America. There is no evidence that maize was known in the Old World until the discovery of America. Brought from America to Spain in the early 16th century it spread rapidly throughout Europe. Within a short time the crop had been introduced into Asia and Africa by Portuguese traders and others. Today maize is grown in almost every country of the temperate and sub-tropic zones. In the northern temperate countries maize may only attain a height of 2½ to 3 ft., whereas sub-tropical maize may reach 20 ft. or more.

Forms of maize

Within this range there is a bewildering diversity of forms. Their classification based on the characteristics of the central endosperm reserves of the seed is inadequate to describe their diversity, but it does cover the major commercial types. Dent maize is characterised by a depression in the crown of the grain. This depression occurs during ripening when the soft starch at the crown shrinks more than the hard starch at the sides of the grain. Flint maizes have roundish grain; the smaller amount of centrally located soft starch is surrounded by hard starch and hence no indentation occurs during ripening. The dent and flint groups together include most of the commercial maizes grown. In general, dents are later maturing, taller, leafier and higher yielding than the hardier flint types.

Sweet corns and pop corns are grown to a smaller extent, chiefly in the U.S.A. Sweet corn has sugar instead of starch as the main endosperm reserve; pop corn, characteristically, has small pointed grain consisting almost entirely of very hard starch. Flour corns, with very soft kernels, are not now much in demand. On the other hand, interest is being taken in waxy corns, since the central starch of this type has properties similar to tapioca.

An American farmer with an ear of the type of hybrid maize which added more than 600,000,000 bushels to the U.S. crop in one year

Production

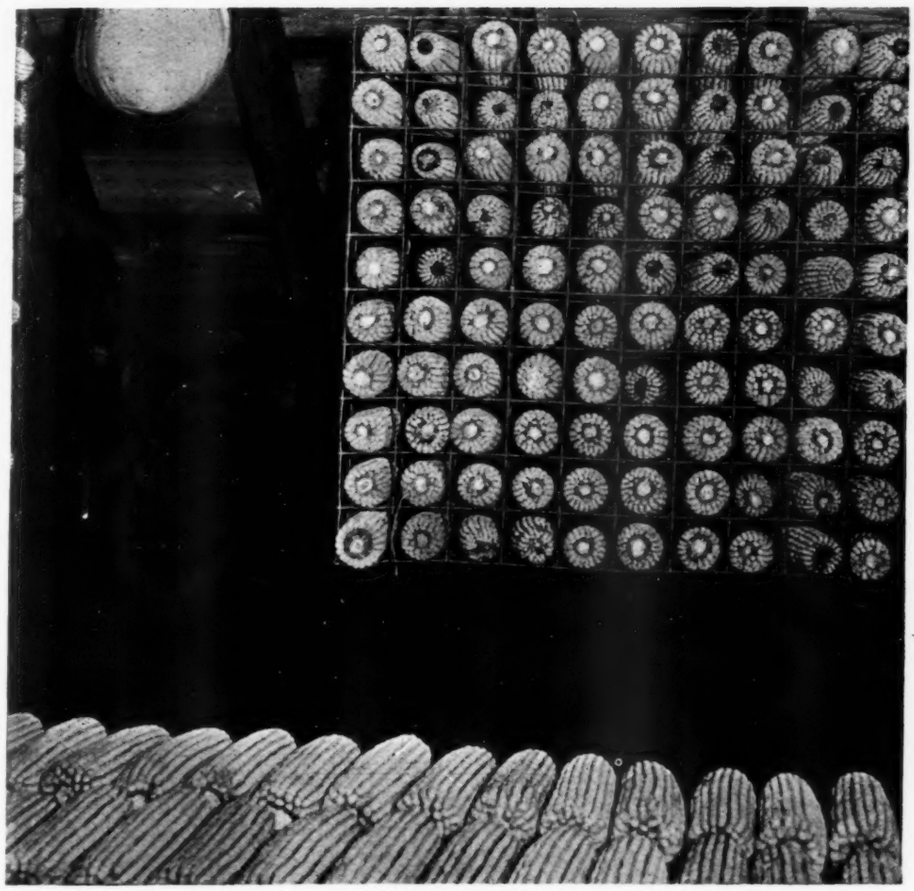
Although maize is a universal crop, nevertheless for the highest productivity it demands special conditions of soil and climate. The important maize-producing areas, given in Table 1, have mean temperatures of 56 to 70°F. at sowing time and 67 to 80°F. at tasselling, together with an adequate rainfall, particularly around tasselling time, and fertile, easily cultivated soil.

Table 1

World Production of Maize in Million Bushels

	Average 1925-29	*Average* 1930-34	*Average* 1935-39	1940	1941	1942	1943	1944	1945	1946	1947
U.S.A. ..	2,739	2,398	2,424	2,573	2,821	3,132	3,034	3,088	2,881	3,249	2,546
U.S.S.R. ..	136	147	170							80	125
China ..		251	262					293	315	301	286
Argentina	297	339	302	403	356	76	344	117	141	229	285
Brazil ..	177	215	215	200	217	203	223	191	225	200	210
Mexico ..	77	71	67	64	84	93	70	94	86	94	87
Rumania ..	179	205	212						44	40	210
Yugoslavia	120	159	176	172					136	60	160
Hungary ..	70	73	92	117				88	74	54	73
Italy ..	98	108	114	135	102	96	66	86	70	87	92
India ..		113	108	89	88	80	101	120	115	113	108
Manchuria	71	67	86	110	102				162		
Egypt ..	77	68	63	60	50	57	54	61	67	56	55
Union of S. Africa ..	64	61	80	87	58	79	87	65	62	87	99
Total world production	4,731	4,340	4,720	4,725	5,040	5,225	5,380	5,190	4,962	5,291	4,830

The data given in the table show that the U.S.A. dominates world production. Maize—or corn, as it is called throughout the U.S.A.—is grown in every state and in both production and value it exceeds the combined American crops of wheat, oats, barley and rye. In the area of maximum production—the ' Corn Belt ' of the Middle West—maize cultivation accounts for half the total arable acreage. More than 70% of the American crop is produced in the ' Corn Belt ' states, but with the introduction of hybrids adapted to shorter growing seasons, maize acreages are increasing in the northern United States and in Canada. In the southern states maize is the next most important crop to cotton. Average yields are lower here than in other parts of the U.S.A., but now that



Open pollinated maize stored for seed in Marshal County, Iowa, U.S.A.

suitable hybrids are available increased production is likely.

Maize growing in Argentina is centred around the port of Rosario on the River Plata. Total production is actually less than in the state of Iowa, nevertheless Argentina is the most important maize-exporting country. From 1934-38 80% of the total Argentinian crop was exported and accounted for nearly 70% of the world trade in maize.

Other exporting countries before the war were Rumania, Yugoslavia, Bulgaria, Brazil, South Africa and Indo-China. The chief maize-producing countries of Europe are in the Balkans, but considerable acreages are grown in Italy, France, Spain and Portugal. In Mexico and much of Latin America maize is a subsistence crop. This is true, also, for many countries of Asia and Africa. In North Africa maize is a most important crop in Egypt, where it now occupies nearly one third of the total cultivated area.

In many other parts of Africa such as Southern Rhodesia and the province of the Union of South Africa maize is the principal cereal crop; climatic conditions are favourable and, with modern production methods together with the introduction of hybrid seed, South Africa is likely to play an increasingly important role in world production and trade.

Methods of cultivation

Primitive methods of cultivation are still used in much of the world maize production. Since maize is a poor competitor with weeds it is invariably grown as a row crop. The comparatively small amount of seed required for planting, together with the high productivity of each plant, makes maize a very suitable crop for peasant cultivation.

When the crop is drill planted singling is normally necessary, but in the U.S.A., where the crop is fully mechanised and special ' check planters ' used, the seed being planted in ' hills ' or pockets, with the hills ' on the square,' no singling is necessary and the crop may be cultivated in both directions.

Harvesting

Following the introduction of hybrid maizes mechanical harvesters have become more popular, since the hybrids ripen more uniformly and stand better at maturity than the old open-pollinated varieties. Nevertheless, most of the world's maize is still harvested by hand. Husking is still done by hand and in the U.S.A. the corn husking championships of the Middle West have become events of national interest. The champions can hand-husk more than 1 ton of ear corn per hour, or one ear per second.

Maize is rarely dry enough to be shelled immediately on harvesting. In the U.S.A. the husked ears are stored in ' corn cribs,' which may be permanent structures with artificial ventilation or simple roofed platforms surrounded by a wire fence. Seed corn should be dried immediately after harvesting. The most satisfactory method is to force hot air up and through bins of ear corn, but in some parts of the world the ears are often hung in bundles to dry. When the moisture content of the grain is 15% or less the grain is removed from the cob, either by hand or, alternatively, by mechanical shellers.

The modern American grain silos are far removed from native methods of storage where storage pests take an enormous toll.

Uses and products

The bulk of the world maize crop is used as a livestock feed. The plant, before or after removal of the ears, may be fed green or ensiled and, moreover, about 85% of the huge American grain crop is fed to livestock. Industry accounts for a further 10 to 12% of the American crop. Foodstuffs manufactured from the meal include starch, dextrins, syrup and sugar, while the edible oil contained in the embryo is an important industrial by-product. Manufacturing ingenuity during the war years greatly increased the range of products derived from maize, and it can be said that no cereal crop has been put to such diverse uses. Penicillin yields have been improved by the addition of maize starch to the fungus nutrient medium; maize cobs are now used in the production of furfural, which is essential in the manufacture of synthetic rubber. Amongst the hundreds of other industrial products from maize are cob pipes, alcohol, cosmetics and rayon.

In North America the direct use of maize for human consumption is largely confined to the sweet corn and pop corn crops, but in many other producing countries maize is the staple food crop.

Improvements in cultivation technique

Considering the importance of maize in the agricultural economy of U.S.A. it is not surprising that most of the improvements in cultivation technique and maize breeding methods have been developed in that country.

With the complete mechanisation of the crop it is now possible for one man to plant, cultivate and harvest 120 acres of maize! Because of the necessity for fre-

quent inter-row cultivation to control weeds, maize was often considered an unsuitable crop for soils subject to erosion, but contour planting has helped materially to reduce the dangers in this regard. The use of selective chemical herbicides for weed control has also had an important effect of late years and although the first field trials to determine the possibilities of the, then, new synthetic growth-regulating substances for weed control in maize were made, in England, as recently as 1944, literally millions of acres are now sprayed annually in the U.S.A. Improved spraying technique, even more efficient chemicals and the breeding of hybrids especially resistant to modern herbicides can be expected in the future.

Hybrid maize in the U.S.A.

The most spectacular recent improvement in maize production has, however, been the introduction of hybrid seed in large-scale commercial plantings. The essential steps in commercial hybrid seed production were summarised by Miss Ashton in a previous article in this journal (Vol. 1, No. 2, October 1949) and the historical background is of interest since it emphasises the difficulties and extent of the research needed to produce commercial hybrids fitted to the environment.

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Increased yields from hybrids

Hybrid seed was first planted in Connecticut in 1919, but in 1933 it still occupied no more than 0.1% of the total maize acreage of the U.S.A. Since then improved hybrid seed has become available from the co-operative maize-breeding programmes of the ' Corn Belt ' states, and hybrid maize has spread rapidly in this area. In Iowa, the most important maize-growing state, 99% of the 9,763,000 acres under maize in 1946 was planted with hybrid seed. The ' Corn Belt ' hybrids have proved adaptable to other regions, and this has led to the extension of state co-operation in maize breeding. Hybrids specifically adapted to the conditions of other states are now available and the importance of hybrid maize continues to increase in the U.S.A.

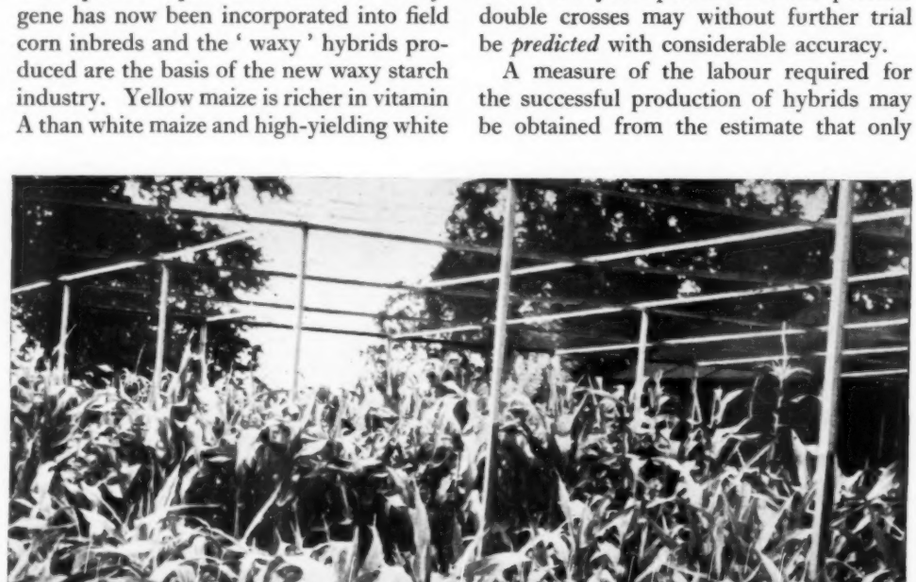
It has been calculated that the use of hybrid seed has contributed more to the national exchequer in *each* of the last four years than the *total* cost to date of the research involved as a result of the increased tax revenue derived from the augmented farm income due to the increased yields.

Other advantages from hybrids

Other advantages from the employment of hybrid seed include greater resistance to the attacks of diseases and pests and improved ability to stand erect when the crop matures. Another point is that selection within inbred lines has made it possible to produce hybrids designed to meet specific requirements. Thus a 'waxy' gene has now been incorporated into field corn inbreds and the ' waxy ' hybrids produced are the basis of the new waxy starch industry. Yellow maize is richer in vitamin A than white maize and high-yielding white maize hybrids have been converted to yellow strains without loss in yield. Conversely, to meet the requirements of the brewing and milling industry, yellow maizes with desirable characteristics have been converted to white maize. Amongst the present breeding aims in the U.S.A. is the production of hybrids with either high oil or high protein contents, whilst studies of resistance to cold in northern U.S.A., Canada and Great Britain may extend the geographical range of successful maize cultivation.

Theoretically the potentialities of hybrids are almost limitless, although in practice their production is time-consuming and very costly; thus selected plants must be selfed by hand pollinations through five or six generations before sufficiently uniform inbred races or lines areobtained. From empirical data itis known that certain inbred lines can combine better than others, *i.e.* produce better hybrids. Generally the most vigorous inbreds combine best, but some high-yielding lines do not combine well. It is still necessary, therefore, to test the combining ability of the inbred lines by crossing them with a common ' tester ' parent. The inbred lines giving the highest-yielding crosses are then paired in every possible combination. From the results of the single crosses produced the yield potential of the possible double crosses may without further trial be *predicted* with considerable accuracy.

A measure of the labour required for the successful production of hybrids may be obtained from the estimate that only



American inlines and first crosses grown experimentally at Oxford in 1949. *Parent inlines in foreground, first crosses in background*

Photos on pages 5, 6, 7 and 9, U.S. Inf. Service

A U.S. Department of Agriculture agronomist pollinating maize silk with pollen from a parent hybrid maize plant. The silk has been covered by a bag to prevent chance pollination

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Hybrid maize in other countries

During recent years the possibilities of hybrid maize have attracted increasing interest in maize-producing countries other than the U.S.A. In Argentina maize production is based largely on open-pollinated flint types with round yellow grain. Inbreeding programmes have been initiated and suitable indigenous hybrids may be developed to meet export demands. Meantime, with the recent increase in the use of maize as a livestock feed in Argentina, American dent hybrids have been successfully introduced. In other countries of central and southern America breeding programmes have been extended with American help and hybrid production is being studied. In South Africa and Rhodesia hybrids from the local maize-breeding programmes are being tested on a field scale. Through the efforts of F.A.O., U.S. hybrids have been widely tested in European countries and several have been found to give significant yield increases over the local open-pollinated varieties. In Italy, for instance, a considerable acreage has been sown to U.S. hybrids this year, and arrangements have been made to maintain the inbred lines and produce hybrids in Italy for future plantings.

Excellent results with hybrids have also been recorded in Egypt, and Egyptian and American hybrids may soon be established in commercial cultivation there. The formation of an association for maize improvement in Europe and the Near East to aid collaboration between maize breeders should facilitate the production of indigenous hybrids. Encouragement for this project is forthcoming from Canadian results with hybrid maize. For several years Canadian maize cultivation was based largely on Wisconsin, U.S.A., hybrids. Canadian-bred hybrids are now available and an extension in maize acreage may be expected.

The production of indigenous hybrids must be the ultimate aim of all areas hoping to obtain full benefit from the use of hybrid maize. American strains are unlikely to be completely satisfactory for the varied conditions of all the different maize-growing areas.

American hybrids

Where maize is important as a direct human food, American hybrids, which have not been specifically produced to meet requirements in regard to palatability, etc., may be inferior to local open-pollinated varieties. Again, in certain regions the very uniformity of development and response, characteristic of hybrid maize, may actually prove disadvantageous. Unfavourable climatic conditions during a critical period (*e.g.* tasselling) or the incidence of some infrequent pest or disease may well cause much greater damage to hybrids than to the heterogeneous open-pollinated crops. Planting a mixture of hybrids of different maturity is only a partial solution to such problems.

The heavier-yielding hybrid maizes make greater demands on soil fertility and soil moisture than the open-pollinated varieties. Where crop yields are limited by these factors, as in many parts of Asia and Africa, the introduction of hybrids would seem to offer little advantage.

Finally, for countries with small acreages of maize the cost of breeding and maintaining the production of hybrid seed corn may be entirely uneconomic until quicker breeding methods are possible.

There are, as yet, no short cuts to the development of successful hybrids. Despite the fact that the genetical make-up of the maize plant is perhaps better known than that of any other crop plant, there is still no adequate genetical explanation for many of the results obtained by the plant breeder. When these problems have been resolved, further advances in maize breeding should be possible.

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The limits of the yields that can be obtained from maize under ideal conditions has been the subject of recent research. In the Columbia River Valley, U.S.A., irrigated hybrid maize which has received 5 acre-ft. of irrigation water and manurial dressings conveying 150 lb. of nitrogen, has yielded no less than 193 bushels of grain per acre or nearly 5 tons! No other creal crop can approach this yield potential; consequently, maize must play an important role in helping to mitigate present and future world food shortages.

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World Bread-grain Crop for 1949 at Pre-war Average

WORLD bread-grain (wheat and rye) production in 1949 was expected to total 204 million long tons, according to information available to the U.S.A. Office of Foreign Agricultural Relations. A crop of that size would be 4% less than 1948's harvest of 213 million tons, but about the same as the pre-war (1935-39) average. Of the total, wheat production is estimated at 6.1 billion* bushels and rye at 1.7 billion bushels. These estimates include preliminary forecasts of production in the southern hemisphere, where the growing crops are in an early stage of development.

The current wheat crop, at 6.1 billion bushels, would be 5% less than the unusually favourable 1948 harvest of 6.4 billion bushels, but still slightly above the 1935-39 average because greatly increased production over pre-war levels in North America outweighs reductions in most other areas. The crop in most important producing areas, however, was smaller than in 1948. Rye production of 1.7 billion bushels is only slightly below that of a year ago, but is 4% below the pre-war average. Continental Europe and the Soviet Union together ordinarily produce more than 95 % of the world's rye crop. Production in both areas was estimated to be slightly larger than in 1948.

Examination of the estimates on a regional basis shows that production was better maintained in the importing areas than in the principal exporting countries. European import needs are expected to continue large, however, with production down 50 million bushels from a year ago, when shipments to that area from all sources totalled about 625 million bushels of wheat and 25 million bushels of rye. Present indications are that bread-grain import requirements during the 1949-50 season may approximate those of a year ago. If output in the southern hemisphere is near normal, export availabilities in surplus-producing countries are expected to be ample to meet world import needs, with another year of reasonable balance between supplies and requirements in prospect.

Wheat production in North America, estimated at 1,518 million bushels, is 182 million bushels less than in 1948. This is the largest change involved in the reduction of 300 million bushels in the world total. The bulk of the change occurred in the United States, where production of 1,129 million bushels is reported, 159 million below the near-record crop of 1948. It is, however, 49% above the pre-war average. Acreage harvested was 5% larger than in 1948 and 32% larger than in 1935-39.

Average yields for all wheat in the United States were between the average for 1935-39 and last year's large yields. Yields of winter wheat were much nearer average than those of spring wheat, which averaged 11.8 bushels per acre compared with 15.4 bushels during 1938-47. Of the wheat production, 895 million bushels, or 79% of the total in the United States, this year was winter wheat. Production in Canada was 372 million bushels, a reduction of 6% from the 1948 harvest. It is still considerably above the pre-war level, however.

Rye production was considerably smaller than in 1948 in both the United States and Canada, because of sharply reduced acreage and smaller yields. The greater reduction was in Canada's acreage, which was down to almost half 1948's large area. Average yields there were reduced by more than 25% and the total output was only 40% of the 1948 crop. Rye production in the United States has declined sharply from the pre-war level of 45 million bushels. The current crop of 19 million bushels is the smallest since 1934. Yields were near average but acreage somewhat less than half the 1935-39 area.

Total bread-grain production in Europe was slightly below the 1948 output and about 12% below the pre-war average. The decline was largely due to reduced acreage, though yields also were slightly smaller than those of 1935-39. A net reduction of about 50 million bushels, compared with the 1948 European wheat total, results mainly from reductions in France, Spain, the Balkans and the United Kingdom. Those reductions are only partially balanced by increases in Italy and some smaller producing countries. Rye production shows little change from the 1948 harvest, with slight reductions in some countries more than balanced by increases in others. The total production, estimated at 665 million bushels, is about 1% above 1948 and acreage 1% below.

Original expectation of good grain production in the Soviet Union has been modified by reports of extensive losses due to unfavourable conditions during and since harvest-time. Harvest difficulties in a number of regions, caused mainly by excessive rainfall, are reported to have resulted in even larger than usual harvesting losses and to have reduced the actual 'barn yields' considerably. Widespread rains in August found much cut grain still unstacked in the fields and further deterioration was expected. Loss of quality as well as quantity is indicated.

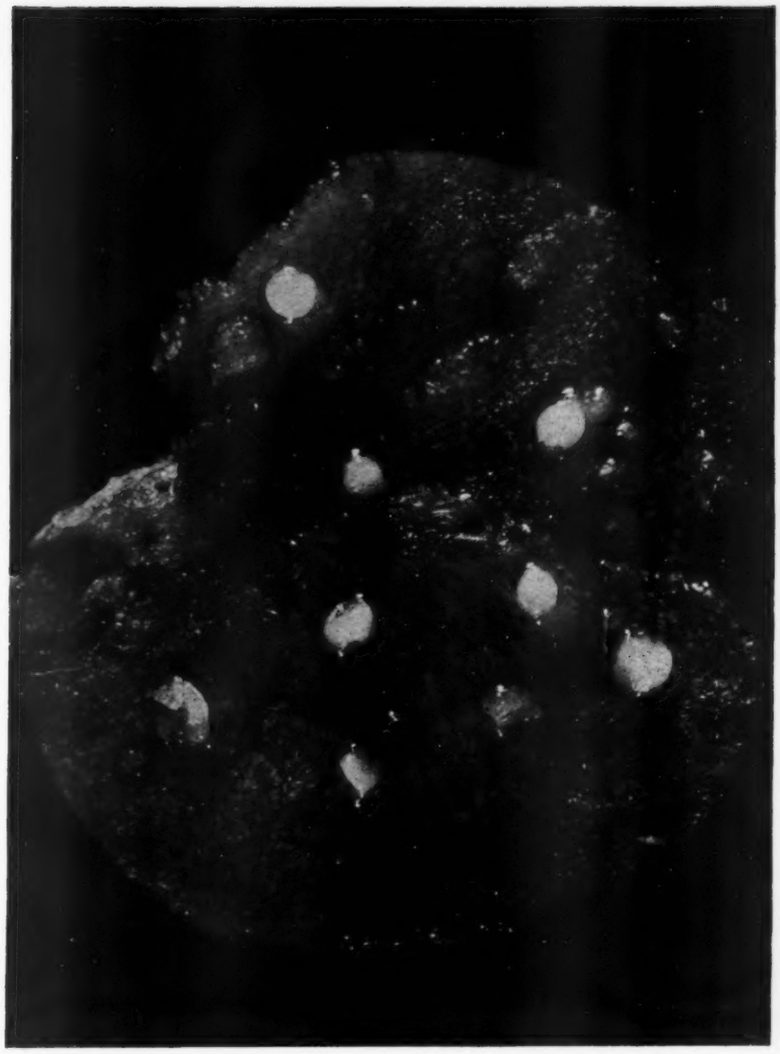
In Asia wheat production was down 8% from the good 1948 crop but was only 2% below the pre-war average, on the basis of latest reports. A reduction of 100 million bushels in China accounts for a large part of the net reduction. The reduction in Turkey is also reported to be substantial, because of unfavourable weather for autumn seeding and drought during the spring growing season. In addition to those changes, reductions of about 15% are reported for Iran and Syria. Reductions are partially balanced by increases reported for India, Pakistan and Iraq. Rye is of no importance in this area except in Turkey, where both acreage and yields are somewhat smaller than in 1948.

The wheat crop in Africa was a little larger than in 1948 as well as somewhat larger than the pre-war production. Increased acreage and larger yields brought it above the pre-war average, but the increase over 1948 was attributed to larger yields from smaller seedings. Production was larger than in 1948 in Egypt and Tunisia, especially in the latter country, where the crop was 80% above the small 1948 harvest. A small reduction for French Morocco and less favourable prospects for the Union of South Africa are not sufficient to nullify gains in other countries. Rye production is not sigficant in this area.

Wheat acreage in Australia is reported to be about the same as the 1935-39 average, which indicates a slight increase over 1948. Development of early-sown grain has been satisfactory, but germination and growth of late-sown wheat were reported retarded by lack of rain, cold weather and frosts. Rains in most deficient areas during the latter part of July improved the outlook considerably. In many areas, however, the rainfall was not sufficient to replenish subsoil moisture reserves, leaving the crop more dependent than usual on timely rains throughout the growing season.

*Billion in America is equal to 1,000 million.

Radial section of infected tomato root showing adult eelworms [*A Shell photograph*



Nematodes as Crop Parasites

B. G. PETERS, M.Sc., Ph.D.

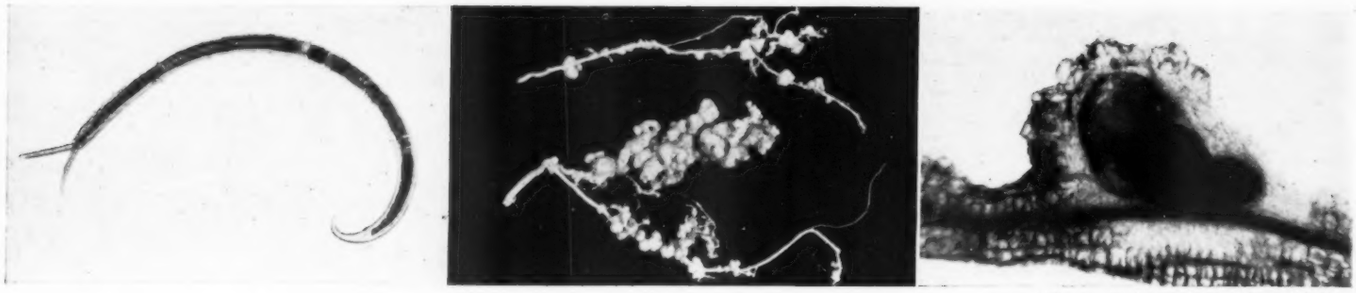
Rothamsted Experimental Station, Harpenden, Herts.

Nematodes are tiny worms which cause disease in crops and animals. There are many thousands of species of which only a few have so far been studied. In this article the author discusses nematodes parasitic in plants of which perhaps the most dangerous is that known as the eelworm, which causes severe damage to hundreds of plants. Methods of controlling nematodes, particularly difficult because they inhabit the soil and can thus re-infect succeeding crops, are also described. Although much research on nematodes remains to be done, and as yet there are few people trained to do it, it is clear that ignorance can favour the growth and spread of these dangerous parasites.

THE nematode worms form a well-defined group of animals, not obviously related to the other animal groups. Thus they are entirely different in structure and habits from the earthworms. Again, many insects pass through a worm-like larval stage, but the nematodes remain worms throughout life. Structurally, the nematode body is not made up of a chain of segments like these others but is all in one piece, and it does not carry legs or other jointed limbs; it gets about simply by wriggling. Moreover, it has a tough, resistant skin.

There are some thousands of species of nematodes but, because they form such an isolated group, they are studied by few biologists, and are mostly too small to be seen by the layman. Some are internal parasites in man or in livestock, and many of these are quite large. Examples are the common roundworm the threadworm, the whipworm and the hookworm in man, and the many intestinal worms, the stomach worms and the lungworms in livestock. A few are parasitic in insects, earthworms and other invertebrate animals. A large number of species are free-living in the sea, in fresh water and in soil. Most of these are around $^1/_{10}$ to $^1/_{20}$ in. long, but are so slender as to be hardly visible without a microscope.

Some of the species free-living in the



[*Photos: Rothamsted Experimental Station*

Left: *A predatory nematode from soil,* Mononchus. *A small eelworm has been seized by its middle and drawn into the mouth.* Centre: *Badly galled cucumber roots infested with root-knot eelworm,* Heterodera marioni. Right: *Early stage of a root gall. The female,* Heterodera marioni, *can be seen as a dark spherical object centrally; above and to the left the more translucent area is an extruded egg mass*

soil feed on decaying plant tissues. If a plant has been damaged by insects or fungi, these 'saprophagous' nematodes will enter the plant and feed upon the decaying tissues; they are not the cause of the damage, but are merely scavengers engaged in clearing up the mess.

Finally, there is a group of nematodes, fairly small in number of species, but of great economic importance, which is truly parasitic in plants. These, commonly called eelworms, will attack a healthy plant and, in sufficient numbers, will cause disease and even death. Different species attack different plants, and different parts of the plant. Some species parasitise the roots, others the stem, others the leaves, and yet others the flowers or fruit. Again, some nematodes are highly specialised as to host; the potato root eelworm of temperate climes, for example, attacks only potatoes and tomatoes. Others are less discriminating; the root-knot eelworm is perhaps the worst offender, attacking many hundreds of plant species scattered through more than 100 natural orders, and including many of the chief tropical crops. Altogether, it is difficult to think of an important crop plant, apart from some trees, which is not known to be attacked by one or other of the plant-parasitic eelworms. Nevertheless, it is only in certain crops and in certain areas that eelworms are a source of serious economic loss. These are areas where general conditions are specially favourable to the parasite.

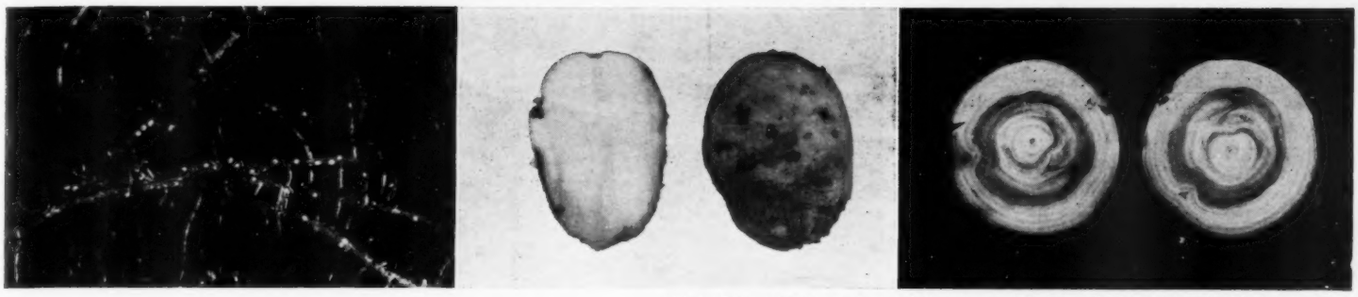
Eelworm population levels

Any parasite leads an exceptionally hazardous existence for, besides the adverse conditions and natural enemies which threaten all organisms, the parasite has the additional hazard of finding a suitable host. The parasite can best insure against this risk by maintaining a high rate of reproduction. Under natural conditions a balance is struck; the high reproduction rate is about enough to maintain the parasite in existence. Typically, one finds wild plants supporting only a few parasites —too few to cause real damage. Only exceptionally will conditions conspire to produce a brief outbreak of disease. The balance between host and parasite is not static but dynamic, like a see-saw. Moreover, it is on a 'live and let live' basis, neither host nor parasite being top dog.

It is man who, with his deliberate cultivations, often upsets the balance in favour of the parasite. Most obviously, this is done when the same crop is grown year after year in the same soil. A good example is the potato root eelworm in the rich soils of East Anglia where potatoes were formerly grown every year on the same land. In the course of years the population of eelworms in the soil increased until there were, say, 100,000 eelworm eggs and larvae in every pound of soil. Under these conditions there was often a complete crop failure, the crop weighing less than the seed potatoes planted. Something could be done by adequately feeding the crop, but it is true of this eelworm (and probably of most) that bigger and better plants support *more*

[*A Shell photograph*

A bunch of tomato roots from plot not treated with D-D, showing heavy nematode infection



[*Photos left and right, Rothamsted Experimental Station; Centre, 'Journal of Helminthology'*

Left: *White cysts (young females) of* Heterodera rostochiensis *attached to potato rootlets.* Centre: *External and internal appearance of potato tuber attacked by* Ditylenchus destructor, *causing a brown rot.* Right: *Brown-ring rot of hyacinth bulbs due to* Anguillulina dipsaci

eelworms. Adequate feeding therefore leads to an increased eelworm population, the crop failing at a higher population level than an underfed crop, but failing none the less. On the other hand, in a year when the yield of potatoes is drastically reduced, so also will be the 'yield' of new eelworms, so that a crop failure may even reduce the total population. Here again there is a dynamic equilibrium, in this case the eelworm population fluctuating around a maximum value at what may be called the 'failure level.' Somewhere well below this level of population there will be a level at which symptoms of disease first tend to appear in the crop; this we may call the 'danger level.' At still lower levels the crop well tolerates its parasite without signs of disease or reduction in yield.

Control measures

Ideally, the object of control measures would be to eliminate eelworms altogether. In certain cases this may be practicable. With care, a bin of potting soil, or the soil in a glasshouse, may be freed from eelworm by steam sterilisation or chemical fumigation. But in most cases, and especially under field conditions, such complete eradication is not possible. Instead (in the terms of the previous paragraph) efforts must be directed to reducing the eelworm population below the danger level and keeping it below. Thus, control becomes a recurrent job and its bare practicability an economic question.

Very briefly, some indication will be given of the physical, chemical, biological and agronomic methods which can be directed against parasitic eelworms. A quite different approach lies, through plant genetics, in the breeding of crop strains which are wholly or partially immune to eelworm attack. Thus, some varieties of winter oats have been found resistant to the stem eelworm. This is a field very little explored hitherto.

Physical methods

No eelworm is known to survive a temperature of 70°C. (158°F.) maintained for a few minutes. Thus heat is a useful control agent, especially in the form of steam-sterilisation of soil, or the warm-water treatment of bulbs infested with stem eelworm. Again, the cyst-forming root eelworms are a great problem in temperate lands, where it is difficult to eradicate them from the upper inch or two of soil; in a tropical soil under bare fallow they would be killed in the upper soil by the sun's heat, which probably explains why they are not important in the tropics. Low temperatures are less useful since most eelworms can withstand freezing if not too prolonged. This applies even to the tropical root-knot eelworm. All the same, its comparative scarcity in temperate lands (except under glass) is probably an instance of low-temperature control.

All eelworms require air and moisture for active life. Some are adapted to withstand drying during a more or less prolonged resting stage; others are not and these are therefore vulnerable to attack by drying. Although active life requires moisture, most eelworms will not tolerate prolonged submergence under water. In all cases a detailed knowledge of the eelworm's life history and habits is necessary before suitable control measures can be devised.

Chemical methods

The spectacular modern insecticides—D.D.T., *Gammexane*, parathion, chlordane and chlorinated camphene—have been shown to be without effect on such a relatively susceptible parasite as root-knot eelworm. The peculiar nature of nematode cuticle appears to render it highly resistant to attack by many chemicals. The best available 'nematocides,' in fact, are fairly simple hydrocarbons containing a few atoms of chlorine or bromine. Such are ethylene dibromide and D-D mixture, both of which are liquids used as soil fumigants, and methyl bromide, a gas successfully used on onion seed and other seeds which carry the infective stage of the stem eelworm. Soil fumigation is not yet well understood, and at present both good and poor control are claimed for the same substance used under differing conditions. On the whole, fumigation is more successful in the warmer soils, and more effective against root-knot eelworm than against the cyst-forming root eelworms; which fact favours its tropical use.

A source of confusion lies in the fact that, although most fumigants are toxic to plants when first applied, they may later stimulate plant growth (giving rise to increased yields), whether eelworms are killed or not. There are even cases of a one-year's increase in crop yield accompanied by an *increase* in eelworm population, due to fumigation.

Biological methods

Much interest attaches to certain predators which feed upon plant eelworms. Thus, some free-living nematodes are predatory in this way, and so are a few of the free-living soil fungi. Some of the latter form rings which constrict about the body of any eelworm which tries to pass through them: the fungus then feeds upon the captured eelworm. While these undoubtedly play a part in nature in controlling eelworms, there is no immediate prospect of utilising them artificially.

Agronomic methods

If an eelworm population can be raised to dangerously high levels by repeatedly growing a susceptible crop on the same land, the converse is also true: the population can be reduced by withholding a susceptible crop for one or more years. Fortunately, most eelworm species die out within a very few years in the absence of a host plant. This is not true of the cyst-forming root eelworms, the eggs of which remain viable for many years within their tough protective cyst. Even here there is some reduction in numbers of eggs each year, but a long rotation of non-susceptible crops is required to undo the effects of a single year of the host crop. And it is not sufficient for the farmer merely to avoid sowing a susceptible crop; for example, after potatoes, self-sets will often grow

year after year and the several eelworms which attack this host are thus kept alive.

A further problem is presented by weeds, some of which may be susceptible hosts in any given case. In this way the potato tuber eelworm has been found to maintain itself on wild mint and sowthistle until potatoes again are grown. Weeds are a pressing problem in relation to stem eelworm, root-knot and many others. Clean cultivation, with or without the use of selective weed killers, thus forms a valuable method of control in some cases.

The eelworm species

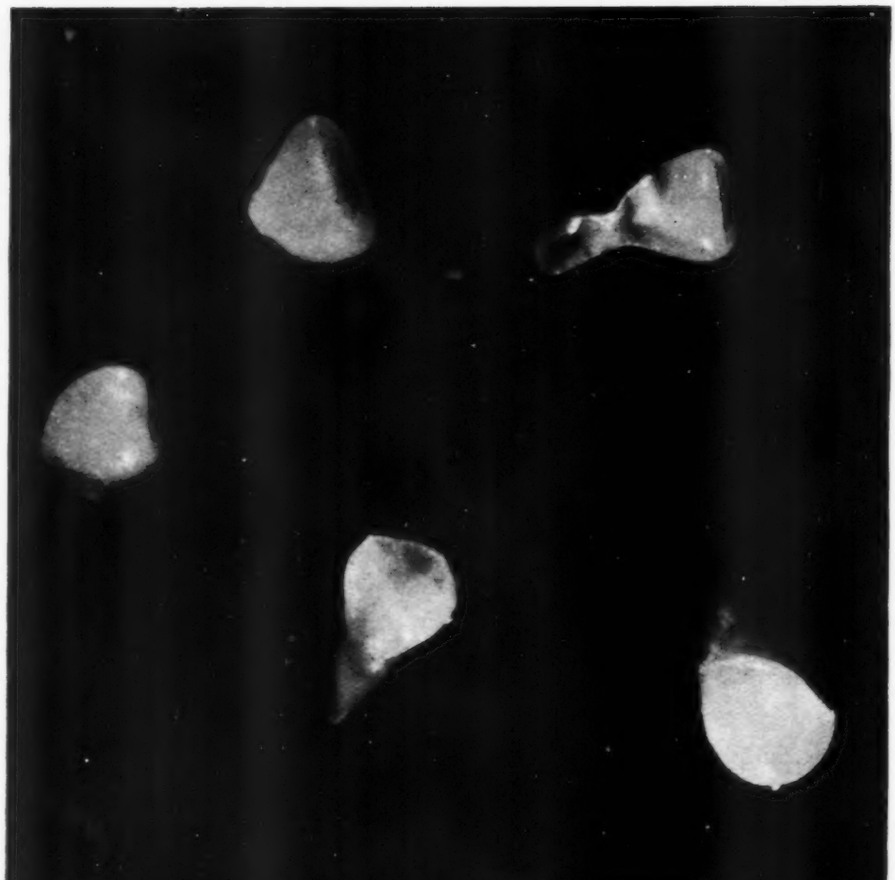
At present we know about 50 species of nematodes which are truly parasitic in plants, but there are doubtless many more still to be recorded, especially from the tropics where very little attention has yet been paid to them. Here it will be possible to mention only a few of the more important ones. All of them carry at the head end a pointed hollow spear which is thrust out through the mouth and aids in puncturing the walls of plant cells.

Root-knot eelworm

On a world view, the root-knot eelworm, *Heterodera marioni*, is the most important of these pests for, although it is scarce in cooler temperate lands, it abounds throughout the tropical and subtropical belts. A bare list of its hosts occupies 20 pages in a recent publication; it may suffice to quote a few: banana, barley, citrus species, clovers, cocoa, coffee, cotton, flax, groundnuts, hemp, jute, maize, oats, pineapple, potato, rice, rubber, soya bean, sugar beet, sugar cane, tea, tobacco and wheat. This list omits many garden vegetables, fruits and ornamentals and large numbers of weeds.

Microscopic larvae penetrate into the roots and grow into adults, the female swelling into a flask-shaped worm about $^1/_{20}$ in. long and producing eggs from each of which a larva hatches, the whole life cycle taking about six weeks. The plant roots respond by swelling into galls (' root knots ') which interrupt the flow of plant nutrients, leading to stunting, wilting and even the death of the plant.

There are so many alternative hosts that it is difficult to control this pest by a rotation of crops, though some strains of cowpeas, velvet beans, cotton, peaches, etc., show a partial immunity. Since the larvae of this eelworm invade the poisonous legume, *Crotalaria spectabilis*, but are unable to develop in it, it is often grown as a green manure crop and ploughed in. The larvae can survive in the soil for only a year or two in the absence of a host plant, so that fallowing is a possible if wasteful method of control. Because of the many weed hosts, it has to be a genuinely bare fallow involving frequent cultivation. Soil fumigation has given promising results in many cases, especially with annual crops. Perennial crops present more difficulty owing to the toxic effects of fumigants on plants, and attention is concentrated on keeping the seed-beds clean and fumigating the final sites shortly before planting out.



[*A Shell photograph*

Cysts removed from infected tomato root

Cyst-forming root eelworms

About ten other species of *Heterodera* are known, all of which differ from root-knot in that the female retains her eggs and swells up to form a tough, protective, spherical cyst. Root galling is absent or slight. The swelling cysts burst out through the root cortex and become just visible to the naked eye as minute bodies, white at first but later turning brown, attached to the roots. As the season progresses they fall off into the soil, where the contained eggs can remain alive for many years.

Each species has a fairly restricted host range, which fact favours control by rotation with non-susceptible crops, but the long survival of eggs entails a long rotation. Moreover, the protective cyst makes successful fumigation more difficult.

Some of the species are: (*a*) *H. rostochiensis* on potatoes and tomatoes in Britain, Germany, Holland, Sweden and Long Island (its only foothold in the New World), which has become a top priority pest of potatoes in England; (*b*) *H. schachtii* on sugar beet, brassicae and many weeds in Europe and North America; (*c*) *H. cruciferae*, also on brassicae; and (*d*) *H. göttingiana* on peas and broad beans.

Citrus root eelworm

Another eelworm in which the female swells into a flask-shaped body is *Tylenchulus semi-penetrans*. This differs from root-knot in several details of structure and life history, and in being restricted to the narrow host range of the citrus species; moreover, the female is attached to the roots like the cystic *Heteroderas* and is not found completely enclosed in large galls. But in the damage done by a heavy infestation and in many aspects of control it resembles root-knot.

Stem eelworm

Anguillulina dipsaci (also referred to as *Tylenchus* or *Ditylenchus*), the stem eel-

worm, is responsible for serious damage to a large variety of plants and is the causal organism of ' tulip-root ' in oats, ' bloat ' in onions, stem sickness in clover and rye, a brown-ring rot of narcissus and other bulbs, etc. In all, it attacks several hundred economic plants and weeds, usually causing swelling or other deformations of stem and leaf tissues, leading to stunting and general unthriftiness. It is a slender worm about $^1/_{20}$ in. long.

A feature of this species is the existence of some eight ' biological strains'; that is, although all appear alike to microscopical examination, each strain is confined to its particular range of hosts. Thus there is an oat-onion-bean strain also attacking mangold, rhubarb and many weeds, a clover strain, a narcissus strain, etc. A particular plant may appear in the ranges of more than one strain, so that the problem of control by rotation with non-susceptible crops becomes very complex.

The infective stage is the pre-adult larva. When the plant dies and dries out, these larvae congregate in hollow stems and other tissues, forming a white fluff (' eelworm wool ') which is visible to the naked eye. If dry, the larvae can remain quiescent for several years and still revive on being moistened. Often the flower tissues are invaded, and infective larvae may become attached to the outside of a seed, or may lie under the seed-coat; in this way infection is spread with the seed. It has recently been shown that the seed of onion and clover can be disinfected by methyl bromide gas without affecting germination.

[*A Shell photograph*

Tomato plants attacked with root-knot eelworm, Heterodera marioni. *Stoner's Ideal variety, sown mid-December* 1947. *Houses were not treated with steam or D-D*

Meadow nematode

The meadow nematode or root-rot eelworm (*Anguillulina pratensis*) is a minute, slender worm about $^1/_{50}$ in. long which attacks the roots of a large number of crops, tropical, subtropical and temperate. In most plants it causes discoloration and finally rotting of the roots. In addition to its own damage, it is suspected of opening the way for harmful fungi. Among important hosts are coffee, cotton, fig, sugar cane, tobacco and many vegetables and cereals. A related species is *A. similis* in bamboo, banana, coffee, pineapple, sugar cane and tea. There is some American evidence that soil fumigation with D-D mixture may be effective. In fact, a fumigant harmless to fungi has been claimed to control a fungal disease of cotton—indirectly, by killing the meadow nematodes which prepared the way for fungus invasion.

Other parasitic eelworms

There are many other species of *Anguillulina* such as those giving rise to flower-galls, leaf galls or root galls on various plants. There are also the species of *Aphelenchoides* causing leaf blotches and other symptoms, some of them living partly as external parasites on the plant. Another external parasite may be mentioned in conclusion: *Anguillulina angusta* causing ' Ufra ' disease in rice. The upper nodes of the stem become discoloured and shrunken, and the rice ear is often barren of grain. Like the stem eelworm, this species produces eelworm wool at the end of the season—a fluffy mass of dry, quiescent worms.

The outlook

Nematology is a relatively new branch of applied biology. In view of the economic importance of many of the problems, outlined above, there is a great deal of research to be done and as yet few people trained to do it. This is partly due to the isolated nature of the nematodes as a group and the consequent paucity of training facilities throughout the world. Apart from the important problems of control, which await a good deal of fundamental research into eelworm physiology, plant pathology, fumigation, etc., there is not yet an adequate survey of the eelworms which exist in the tropical and subtropical belts.

*Chemicals, Humus, and the Soil**

The thunderings of the ' muck-and-mystery ' conventicle of denigrators of chemical fertilisers and upholders-at-any-cost of ' natural manures ' have diminished lately—possibly owing to the departure of Sir Albert Howard to a sphere where, it may be hoped, the cherubs have no bottoms to reproach his sublunary infirmities. His faith was nothing if not certain. Orthodox modern agriculturists, and particularly British scientists of the Rothamsted school were, and are, targets for the devotees of compost; yet the only agricultural scientists of note who have laid undue stress on ' mineral ' fertilisers were a German and a Frenchman who flourished last century. Upon arbitrary misconceptions did the Howard testament burgeon. As Mr. Hopkins points out (quoting Stephen Leacock), a half-truth, like a half-brick, is a more forcible argument than a whole one: it carries further. That the unqualified assertions about the value of humus and the defilement wrought by fertilisers upon worms were seldom countered in words by orthodox scientists was partly due to their perceiving that it is useless to discuss a man's religious beliefs, and vain to repudiate the soundness of the dogmatic basis of his creed or to argue point by point about the reasonings he erects upon a given doctrinal foundation.

Mr. Hopkins has nevertheless been goaded into this detailed reply, which amounts to a very patient, gentle and unassuming examination and statement of the case for using both fertilisers and organic manures in order to maintain present standards of food production. His argument might have been more telling—more readable, even—if he had been more forthright and had gone more for first principles. As it is, he deals very quietly with folly, and is at pains to grant all that can be granted and to hurt nobody's feelings.

To chemists the book will be a useful source of notions about British chemical requirements for agricultural and horticultural production. The book is not a treatise on fertilisers. It seeks mainly to give reasons rather than statistical facts: to explain *why* rather than to say *how*; and it justifies its sub-title, ' a simple presentation of contemporary knowledge and opinions about fertilisers, manures and soil fertility.' It is therefore unique, and recognition of its value and interest is expressed by its going into this third edition.

HUGH NICOL, *Ph.D.*

*By Donald P. Hopkins. 3rd Edition (revised). Faber, London. 1949. Pp. 278. Illustrated. 12s. 6d.

Progressive Methods in Southern Rhodesia

WITH a European population of 115,500 and close on 2,000,000 other people, Southern Rhodesia needs more than anything else increased production of animal products for food, said the Prime Minister, Sir Godfrey Huggins, opening the Bulawayo Agricultural Society's thirty-sixth show on September 2.

With improved standards of living and higher wages there was an ever-increasing demand for more farm products, particularly food derived from animals. This increase in the local market was essential for stabilising the farm industry. The colony, said Sir Godfrey, should be able to produce all the beef, mutton and pork required by all sections of the community.

Old ranching methods could be improved and new ranches could be started on improved methods, but the mixed farm would be the mainstay of the industry. ' We can also look forward to considerable increase in production from the native reserves and native areas,' said Sir Godfrey.

Long-term policy impossible

'A long-term agricultural policy should not be contemplated for Rhodesia until more is known about the country's farming conditions. I hope Sir Frank Engledow's report will stop this political tag of a long-term agricultural policy. Anyone who wants such a policy should go to a country several hundred years older than this one.' Sir Godfrey congratulated those who had organised the show, adding it was one of the best he had seen.

The possibilities of developing the Sabi-Lundi area of Southern Rhodesia on the same lines as the great American Tennessee Valley scheme were discussed by Mr. A. C. Soffe, chairman of the Eastern Districts Regional Development Association, on September 6. Mr. Soffe visited the Tennessee Valley in 1946. As with the Tennessee Valley, he said, a great deal of the future of this colony might rest on a huge deposit of phosphate in the Sabi Valley. Local problems of soil conservation, the necessity for building big storage dams and using the outflow first to generate power to release the phosphates, and for irrigation after that, had something very much in common. In contrast with the Tennessee Valley, the problems of the Sabi-Lundi area concerned a valley which was under-populated. Its agricultural possibilities, its production of minerals such as phosphates, iron, vermiculite and coal were almost completely unknown. The land involved started from the highest points in the whole of the colony, and included mountain streams from the Chimanimani Mountains and the Inyangani Highlands downwards. It embraced nearly a third of the colony's total area. Some of its greatest importance lay in the fact that within its area was the colony's greatest irrigable region.

The experiments of the Native Department on irrigable areas had been a success. Almost every possible crop was being grown, including maize, wheat, legumes, lucerne, sorghums, vegetables and a wide range of tropical fruits. The colony's hessian and grain bags would also come from Sabi. This area represented the colony's only known possibility of providing unlimited food of a balanced nature to the rapidly increasing native population.

Appeal for better quality tobacco

Tobacco growers must take advantage of the present situation and, with the emphasis on quality, try to put the tobacco industry on sound lines, so that when the time came Southern Rhodesia could face open competition on an equal footing with other countries, said Mr. R. B. Harland in his presidential address at the annual meeting of the Rhodesia Tobacco Association in Salisbury on September 6. Tobacco was a 95% exportable commodity and, therefore, the colony had little control over the demand or price, Mr. Harland said. If it were not for the monetary situation, America could over-supply the British market in two seasons. ' We have a golden opportunity to establish our product on the world's market, but will be losing it if we do not put our house in order now. It would be fantastic to think that we could go on for all time producing about 600 lb. to the acre, while America and Canada—who may one day be our competitors—are producing at least 50% more.' Mr. Harland urged growers to put quality before everything else, and warned new growers especially not to base their calculations on the present prices of low-grade tobacco. Referring to the tobacco industry target of 120,000,000 lb. by 1953, Mr. Harland said that the Government had stated more than once that it supported the industry in its drive.

Tobacco production

In an address to the meeting, Dr. A. E. Romyn, Secretary for Agriculture, said that objections to the Tobacco Savings Levy had brought to the fore the extravagance of much of the recent production of tobacco. The object of many producers had been to increase turnover with little attention to cost. The big programme of tobacco production would be dearly bought unless waste was cut down and the average standard of financial efficiency in tobacco growing was raised. ' We need expansion in the industry,' said Dr. Romyn, ' but we should try to fit development as far as possible into a system of stable agriculture.'

Soil Survey in South Australia

LAND along the Murray River in South Australia which was originally classed a marginal country because of its low and variable rainfall may be a thriving irrigation settlement in eight years' time. Following on favourable soil surveys by the Commonwealth Scientific and Industrial Research Organisation, the Federal Government has acquired 12,000 acres of this land for the creation of such a settlement.

In announcing the acquisition, the Minister for Post-War Reconstruction, Mr. Dedman, said that the surveys showed that the land was generally suitable for growing citrus and stone fruits, vines for wines and dried fruits, and fodder crops.

The country lies between Loxton and Berri, which is about 120 miles to the north-east of Adelaide. The Government will install pumping stations, electric generating plant, channels and other irrigation equipment. It will be necessary to raise the water 110 ft. from the Murray into channels for retriculation to the farms.

The Minister said that the trees and vines should reach commercial production in from four to eight years from the time of planting. During that period settlers would be given financial assistance—its amount based on the productive value of holdings and not on the costs of development.

Pre-harvest drop of apples and pears regularly accounts for large annual losses. In most varieties it can now be prevented by the timely application of a hormone spray. The photograph shows the contrast between sprayed and unsprayed trees in the same row

How Plant Hormones Aid Crop Production

L. C. LUCKWILL, B.Sc., Ph.D.

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Plant hormones occupy a very important place among the resources of the scientific agriculturalist. Probably the greatest publicity is attached to them in their role as selective weedkillers, but their uses in promoting and assisting plant propagation, in producing seedless plants and the control of fruit drop are also very important. In this article various ways in which these substances can be used to increase crops are discussed.

FROM the dawn of agriculture man has sought to increase his control over the growth of plants. By tilling and irrigating the soil and by the use of manures and fertilisers he has endeavoured to provide for his crops the best possible conditions for growth and fruitfulness, at the same time suppressing the growth of undesirable weed species by cultivation. More recently the use of insecticides and fungicides has enabled him, to a large degree, to protect his crops against pests and diseases, thereby increasing still further their growth and yield.

All the above methods have one thing in common: they seek to influence the growth of the plant by altering in some way its external environment. There are, however, other methods of influencing growth which are based, not on changes in the environment, but on interference with the internal physiological processes controlling growth. This is, in effect, what is done when a fruit tree is pruned, or when cereal crops in the seedling stage are rolled to encourage tillering from the base. Also in this category might be included vernalisation treatments, where, by subjecting the plant to low-temperature treatment at a certain critical stage in its life history, its flowering and fruiting may be hastened. More recently the discovery of plant hormones has provided us with still more potent methods of controlling the internal growth processes of plants. Although the study of these substances is still in its infancy the results already achieved have in many cases proved of great practical value, and it seems certain that growth-regulating chemicals of this type are destined to play an important role in crop production in the future.

What are plant hormones?

It has been discovered that plant tissues require for their growth, not only adequate

supplies of water and food materials, but also minute quantities of certain specific chemical substances. These growth substances, or hormones, are normally manufactured in the actively-growing tissues at the tip of the stem and roots, in buds, leaves and seeds, and from these regions they are transported through the plant to other organs whose growth they influence.

They are thus directly comparable to the hormones of the animal body, secreted in the ductless glands and passing into the bloodstream and often producing their characteristic effect far from their site of origin.

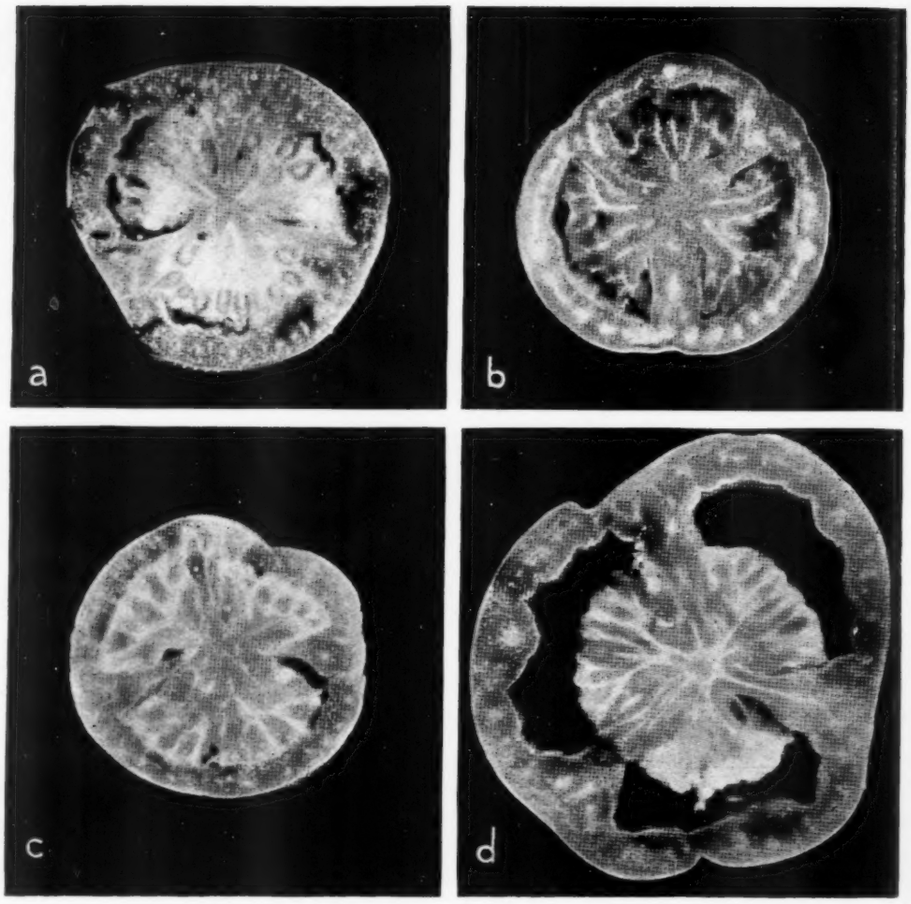
In the plant we know that substances of this type control the growth of the stem, root and leaves, and are responsible for the bending which these organs undergo under the influence of light and gravity. They are also known to play a major role in fruit development and their disappearance from the leaves of deciduous trees in the autumn is the immediate cause of leaf fall. There is also much evidence that similar substances are concerned with the initiation of flowering in the plant, with the healing of wounds and with the dormancy of buds and seeds.

The chemical nature of substances with such far-reaching effects on plant growth is obviously a question of very great interest and importance—not only to the plant physiologist—but also to the grower, who is always seeking to increase his control over the growth of his crop plants.

Unfortunately our knowledge of the chemical nature of plant hormones is at present somewhat limited. This is due chiefly to the extremely minute quantities of these substances normally present in plant tissue, which makes their extraction and purification very difficult. We can, however, detect their presence and measure the relative amounts of hormone present in various tissues by biological assay methods, without actually separating the active compound.

Up to the present only four true plant hormones have been isolated in sufficiently pure form to be identified chemically. These are auxenolonic acid (auxin b), auxentriolic acid (auxin a), indolyl acetic acid and traumatic acid (the wound-healing hormone). Of these only the last two have been synthesised in the laboratory.

Within recent years, however, a whole range of synthetic chemical substances been prepared which influence the growth of plants in the same way as do the naturally occurring plant hormones. As these substances are not known to occur naturally in plants they are often called growth-regulating substances to distinguish them from the naturally occurring plant hormones. Recently, however, popular usage has extended the latter term to include all stances capable of exerting these specific growth effects, irrespective of whether they originate in the plant or in the laboratory.



Transverse sections of tomatoes: (a) *Normal seed fruit produced by natural pollination;* (b)-(d) *parthenocarpic fruits produced by treating unpollinated ovaries with* (b) *2-naphthoxyacetic acid,* (c) *an extract of apple seeds and* (d) *2-4-dichlorophenoxyacetic acid*

One characteristic which these synthetic plant hormones share with their naturally occurring counterparts is that they are active in extremely minute quantities. Thus, 2:4 dichlorophenoxyacetic acid, a widely used hormone, is still capable of producing a measurable effect on growth after dilution in one thousand million times its weight of water.

The chief purpose of this article is to review some of the ways in which substances of this type can aid crop production. So widespread are their applications that it will only be possible to refer here to a few of their more outstanding contributions to horticulture and agriculture.

How plant hormones help the propagator

Shortly after the recognition of indolyl acetic acid as a plant hormone it was noticed that plants treated with this substance often developed roots in the most unexpected places—for instance, on the leaves and stems. Many other synthetic hormones have since been found to possess this property of stimulating root formation and as a consequence have found wide application in the vegetative propagation of plants. By treating the base of cuttings with the appropriate strength of hormone solution or dust, they can be made to root more rapidly and more prolifically—a method which has proved especially valuable in the case of species normally difficult to root in this way.

In the past the chief use of these substances has been in the propagation of ornamental plants, particularly shrubs, but recently much work has been done on their application to the vegetative propagation of crop plants. At East Malling Research Station they have been successfully used in the propagation of certain fruit tree rootstocks; in California they have been used in the propagation of olives by cuttings, and have proved particularly valuable for the Sevillana variety which is normally difficult to root; among tropical crops cuttings and marcots of Derris, Cinchona and Cacao

have been shown to root much more readily after treatment with growth substances.

Control of flowering

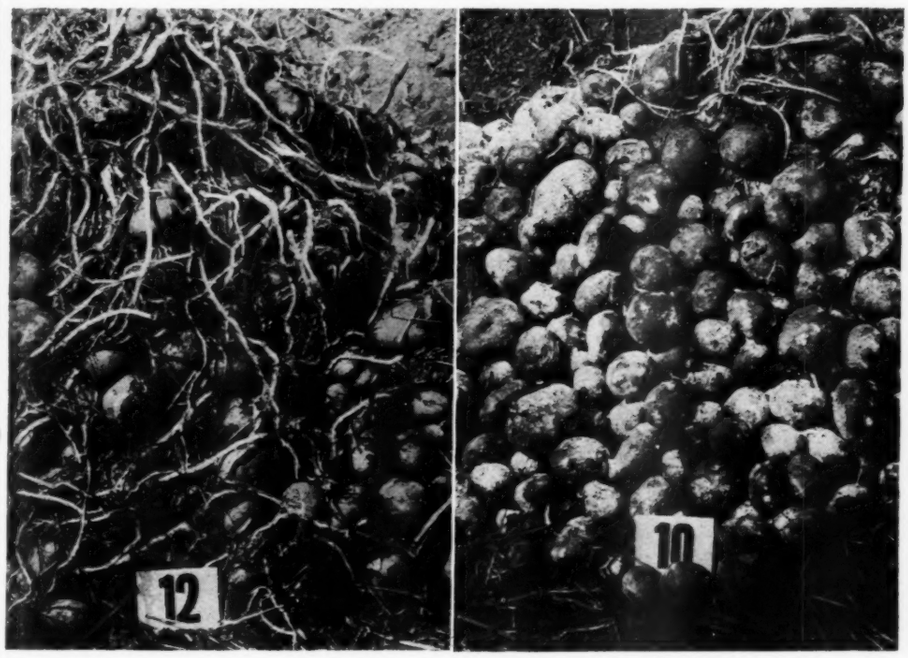
The internal factors which lead to the production of flowers and which cause a complete plant or an individual bud to change suddenly from the vegetative to the reproductive condition have long been a subject of controversy amongst plant physiologists. Nutritional factors are known to be important, but within recent years much evidence has accumulated which points to the existence in plants of specific ' florigens,' or flower-forming substances of a hormone nature. It has been demonstrated experimentally that such substances are manufactured in the leaves and that they can be transmitted from one plant to another by grafting. Although nothing is known as to their chemical nature it has proved possible in certain cases to produce similar florigenic effects using synthetic growth substances.

The lateral shoots of the tomato, which normally develop as leafy structures, can be changed into flower trusses if the young plants are sprayed with a solution of 2-3-5-tri-iodo-benzoic acid. The ultimate result of this treatment is a tomato plant with several thousand flowers but possessing very few leaves. Such botanical monstrosities, although of no value to the grower, do provide very convincing proof of the fact that it is possible by chemical means to convert vegetative tissue into flowering tissue.

In the Cabezona pineapple, widely grown in the West Indies, the chemical control of flowering by means of plant hormones has recently assumed great economic importance. This particular variety of pineapple is characterised by its irregular flowering behaviour. Individual plants, after reaching maturity, may come into flower during any month of the year, so that rarely more than 5% of the crop is flowering at any one time. Moreover, certain plants of this variety may remain vegetative for periods of two to five years before they finally produce a flower head, although other varieties regularly crop in their second year.

It has recently been shown that the application of a dose of 0.25 mg. of the plant hormone, 1-naphthyl acetic acid, to the crown of a Cabezona pineapple plant is effective in initiating flowering, and by this means it has proved possible to bring whole fields into flower simultaneously. Moreover, since the treatment is effective at any period of the year it is possible by this means to produce a crop at any desired time, thereby greatly extending the normal harvesting and marketing season. Not only does the use of hormones enable the pineapple grower to control the harvesting season; it also provides him with a means of controlling the size of his fruit. It has been shown that the size of a pineapple is closely correlated with the number of leaves on the plant. Thus, if the hormone treatment is applied after the plant has produced 20 leaves, the fruits average 2 kg. in weight; if they are allowed to produce 30 leaves before treatment the average fruit weight will be about 3 kg.; and for 35 leaves 4 to 4½ kg.

Thus the reluctance of the Cabezona pineapple to flower, which was formerly a disadvantage has, by the use of hormones, been turned to great advantage, enabling the grower to control both the time of harvest and the size of crop. The treatment has the further advantage that it increases the number of axillary shoots or ' slips,' by which the pineapple is propagated, and which provide the material for new plantings.



Excessive sprouting of ware potatoes from storage leads to rapid shrinkage and deterioration of the tubers (left). *Sprout growth can be greatly inhibited by treating potatoes at the time of storage with a hormone-containing dust. The result is seen in the right-hand photograph*

Fruit without fertilisation

One of the most spectacular uses of plant hormones has been for the production of seedless fruits of certain plants. In most plants the growth of fruit is dependent on the development of fertile seeds, and hence upon the process of pollination, followed by the fusion of the male and female sex cells within the ovule (fertilisation). If, for any reason, pollination fails to occur, no fruit develops. There are, of course, obvious exceptions to this rule; the banana, the Washington Navel orange and certain varieties of grapes and cucumbers have developed the ability to produce fruits without the necessity for pollination and seed growth. In some other plants which do not possess this ability seedless fruits can be obtained by treating the unpollinated ovaries with growth substances. Tomatoes respond particularly well to this treatment, and hormone sprays are now in regular use by tomato growers in England and the United States. The value of such sprays lies, not in the seedlessness of the resulting fruit, which is of no particular advantage, but in the fact that it is possible to produce crops of tomatoes under conditions unfavourable for natural pollination. In northern latitudes such conditions frequently occur during the early months of the year in glasshouses; the chief factor here is low light intensity, which prevents proper ripening of the pollen. Under field conditions pollination may fail as a result of too high or too low temperatures, low humidity or excessive rainfall. Whatever the cause of failure the fruit fails to set properly and only a partial crop is obtained. By the use of a spray containing 50 p.p.m. of 2-naphthoxy-acetic acid, applied to the flowering trusses, the grower can ensure close on 100% set whatever the conditions. Where pollination has not taken place the fruits are seedless, but are otherwise normal in appearance, taste and nutritive value.

Not all plants respond to these substances as readily as does the tomato and

it has not yet proved possible to produce seedless apples, pears or plums by this method. In California, however, plant hormones are now being used in the production of seedless Calimyrna figs.

The cultivated fig bears only female flowers and when it was first introduced from southern Italy into California it was found necessary to bring with it specimens of the wild caprifigs. These contain not only the pollen-producing male flowers but also the special *Blastophaga* wasp, upon which the cross pollination of the fig depends. In the past the grower of Calimyrna figs has either had to maintain caprifig trees in his orchards or to hang caprifig branches in his trees at pollination time, an expensive and somewhat uncertain operation. By the use of hormone sprays figs can be made to grow without the need for caprification. The figs produced by this means do not differ from normal caprified figs in colour, size, shape or flavour, but they have the very decided advantage of being seedless. Indolyl butyric acid at a strength of 1,500 p.p.m. is the most effective substance so far found for setting figs. Another plant hormone, 2-4-5-trichlorophenoxyacetic acid, has the remarkable property of hastening the maturity of the fruit, so that the figs ripen in approximately 60 days as compared with the average 120-day period necessary for normal development. It is probable that this substance, too, will soon find wide application in commercial fig production. Its action is in many ways similar to that of ethylene gas, which has long been used as an agent for hastening the ripening of green-picked bananas and other fruits.

Control of fruit drop

In the production of high-quality early dessert apples one of the difficulties encountered is that as the fruit approaches maturity it tends to fall from the tree before it has developed its full flavour and colour. The grower is therefore faced with the alternative of picking his fruit early or of risking the loss of a large proportion of the crop as windfalls.

By the application of a hormone spray about a fortnight before the normal picking date the drop of most varieties of apple can be delayed for several weeks, and the grower is able to leave the fruit on the tree until it has attained its full size and colour. On farms where large acreages of the same variety are grown the use of such sprays also enables the farmer to spread his picking season over a much longer time than would otherwise be possible—an important consideration where labour is short.

In the United States large acreages of apples and pears are now sprayed annually with drop-preventing hormone sprays, and aeroplanes and helicopters are being increasingly used for rapid application of such sprays. In England and other countries, too, the use of pre-harvest drop sprays is becoming increasingly popular with the larger growers.

Use of 2:4 D

In the past alpha-naphthalene acetic acid applied at a strength of 10 p.p.m. (for ground application) has been almost exclusively used for this purpose. More recently 2:4 D (2:4 dichlorophenoxyacetic acid) has also been employed and on some varieties has proved more effective than the naphthalene compound; 2:4 D has also been used with good effect against the dropping of citrus fruits.

In England experiments have been carried out with similar sprays for the control of the so-called 'June' drop of apples, which occurs when the fruit is about half-grown. With Cox's Orange Pippin, a variety which is likely to shed a large proportion of its crop in the June drop, it has been shown that a hormone spray applied just before the drop starts is effective in increasing the harvested crop by 50 to 60%.

Alpha-naphthalene acetic acid added to summer white oil sprays has also been shown to be effective in preventing the fall of leaves and fruitlets which often follows the use of such sprays for the control of red spider on apples.

Hormones as weedkillers

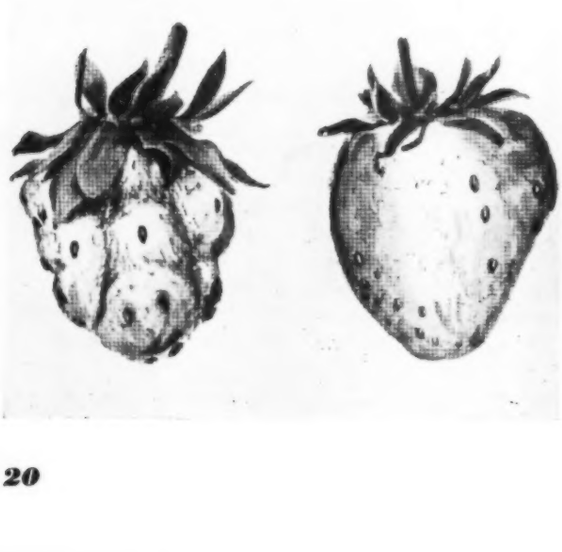
At extremely low dilutions most plant hormones stimulate growth; at somewhat higher concentrations this effect is reversed and growth is inhibited. This property of inhibiting growth has been made use of in the commercial storage of ware potatoes. By storing the potatoes in the vapour of methyl 1-naphthyl acetate it is possible to suppress the growth of sprouts and keep the potatoes in good condition from one season to the next. Another growth-inhibiting compound is used for treating seed potatoes to prevent excessive sprouting in the sacks.

At still higher concentrations—of the order of 0.1%—many plant hormones are definitely toxic to certain plants. Not only is growth inhibited, but the respiration rate is increased to such an extent that the plant eventually exhausts its reserves of food material and dies. For some reason as yet undiscovered certain plants, particularly grasses and cereals, are highly resistant to this toxic action, and it is this fact which has made possible the use of plant hormones as selective herbicides.

Two main compounds

The two hormone compounds which have been most widely used as weedkillers are 2:4 D and MCPA (2-methyl 4-chloro-phenoxyacetic acid). These two compounds are, in general, similar in their action, though certain plants are more susceptible to one than to the other. In cereal crops, applications of either of these substances at the rate of only 1 lb. per acre when the corn is a few inches high, gives good control of annual cornfield weeds. For perennial weeds such as occur in established turf, somewhat higher rates of application—of the order of 3 to 4 lb. per acre are required. Very large quantities of 2:4 D are now used annually for the control of weeds in wheat, oats, barley, sweet corn, rice and sugar cane, and preliminary trials with flax and linseed have shown considerable promise.

It is possible that in the future selective weedkillers of the hormone type will be developed for use on other crops, and it may well be that this particular application will eventually prove the most valuable of all the manifold contributions of plant hormones to crop production.



[*All photos in this article by courtesy Long Ashton Research Station*

The effect of seeds on fruit development is well illustrated by the strawberry. Where pollination is inadequate few fertile seeds are formed and misshapen fruits like those on the left result. The fruit on the right has been sprayed with a synthetic growth substance (α-naphthalene acetic acid), ensuring full development of the flesh

Ploughing paddy fields after the heavy rains

Rice Supplies in South East Asia

Indonesia, the Philippines and Malaya make up the rice consuming countries of South East Asia. Their combined populations total approximately 95 million people, the great majority of whom depend on rice for their chief article of diet. In all of them rice is grown to a greater or lesser extent, but none is entirely self sufficient, and all depend upon imports for a portion of their requirements. The entire region suffered severely as the result of the Japanese invasion in 1941-42; since then partial recovery has occurred and efforts to extend rice production have been continued unremittingly. Rice supplies are the factor which more than any other dominate the economic position in these countries, and while supplies at present are not entirely inadequate, despite the difficulties, the greatly enhanced prices are a powerful factor which profoundly affects the production of export crops and influences political stability and security. The world depends on this region for so many tropical products that an examination and comparison of the present position in regard to rice supplies is of considerable interest and importance. The following account, which has been compiled from information received from official sources, enables the present situation to be assessed.

INDONESIA

INDONESIA comprises the central territory of Java and Madura and the outer provinces which include Sumatra, Celebes, Southern Borneo, Western New Guinea and many smaller islands.

It has long been the aim in these territories to make them so far as possible independent of imported sources of supply, nevertheless there has always been some importation of rice. To maintain the position the Government in the pre-war period severely restricted imports and controlled the purchase of locally grown rice in those areas of Indonesia which produced rice surplus to local needs and which could be exported to other regions of the territory where supplies were deficient. Subsidies were paid to make interinsular transport of rice as cheap as possible.

During the war rice supplies became difficult; since the war it has improved but is still below the pre-war level. Table 1 shows the pre-war position in regard to

TABLE 1

PRODUCTION, IMPORTS AND CONSUMPTION OF MILLED RICE IN THOUSANDS OF LONG TONS

	Average 1934-39	1948	1949
Net production:			
Java and Madura	4,266	3,670	4,212
Outer Provinces	2,660	2,650	2,574
Total production	6,926	6,320	6,786
Imports from foreign sources	261	237	250
Total consumption	7,187	6,320	6,786
Population in millions	67	69	70
Estimated per capita consumption in kilos per annum	101	89	91
Equivalent in lb. per annum	222	195	200

TABLE 2

PRODUCTION, IMPORTS AND CONSUMPTION OF MILLED RICE IN THE PHILIPPINES IN THOUSANDS OF SHORT TONS OF 2,000 LB.

	Average 1936-40	1946	1947	1948	1949†
Combined production and imports	1,502	1,193	1,322	1,394	1,597
Rice-eating population in millions*	11.0	12.8	13.1	13.4	13.7
Estimated per capita consumption in lb. per annum	270	185	201	205	229

*The rice-eating population accounts for approximately 66% of the total.
†Estimated.

TABLE 3

PRODUCTION, IMPORTS AND CONSUMPTION OF MILLED RICE IN THOUSANDS OF LONG TONS

	1939	1940	1941	1946	1947	1948
Production	341	335	324	225	257	343
Imports	659	635	539	136	237	449
Total consumption	1,000	970	863	361	494	792
Estimated population in millions	5.0	5.1	5.2	5.6	5.7	5.8
Estimated per capita consumption in lb. per annum	448	422	371	145	194	308

production, imports and consumption as compared with the situation in the two post-war years 1948 and 1949.

Cultivation

Rice is grown in Indonesia on:

(*a*) Unirrigated wet fields on which rain water is conserved by means of bunds constructed by the cultivators.

(*b*) Irrigated fields on to which water is is led by roughly constructed irrigation works made by the cultivators themselves.

(*c*) Irrigated fields which derive their water from irrigation works scientifically designed and constructed by the Government.

(*d*) Permanently cultivated dry fields, mainly in Java and Madura.

(*e*) Shifting cultivation of dry lands which are cleared from jungle and after cultivation for a few years again revert to bush.

Of the above, (*b*) and (*c*) account for the bulk of the cultivated area.

In 1940 there were 3,384,000 hectares of irrigated land, of which 1,310,000 were provided with scientifically designed and controlled irrigation. Much of it was cropped twice and some three times a year; (*d*) accounted for 265,000 hectares, while the exact extent of (*e*) is not definitely known. The irrigated and also unirrigated lands are used for growing other food crops including maize, pulses and root crops such as sweet potatoes and cassava.

Between 1930 and 1940 there were considerable extensions of irrigation and although the population increased considerably, rice production increased still more and rose from 3,872,000 metric tons to over 4,700,000 metric tons in 1940. A considerable part of this increase was, however, due to double or treble cropping.

In 1949 the rice harvest was good, but the weather conditions which favoured rice growing were unfavourable to other food crops. It is estimated, in consequence, that maize consumption per capita is 20% less than before the war and root crops per capita 18% less than before the war.

Limited supplies have brought high prices in their train and this affects costs of production of export crops, leading to decreased output, high cost of living and consequent distress and political unrest.

PHILIPPINES

In the Philippines, as in Indonesia, the aim of official policy has been for many years to lessen dependence on imports by increasing domestic production, but there still remain appreciable imports.

The per capita consumption of milled rice by Philippines consumers in 1949 is estimated at 17% below the pre-war average (1936-40). The consumption rate has been rising since 1946, when it dropped 35% as the result of World War II. The reason it has remained below pre-war in 1949, however, apparently is not because supplies are fewer, but because the population has increased faster than supplies. Both the 1948-49 crops and 1949 imports have been larger than before the war.

Table 2 shows the pre-war and present-day position in regard to supplies and consumption.

Despite plans to increase production in 1949-50, the planted acreage is about the same as in the year before. The rice area is forecast at 5,250,000 acres, compared with 5,267,000 acres in 1948-49 and with the average of 4,934,000 acres before the war (1936-37-40-41). Lack of rainfall during the seeding period was the most important factor preventing an increase, and infestation of army and cut worms more serious than usual destroyed part of the upland rice and seedlings to be transplanted.

Rice imports into the Philippines during the first half of 1949 totalled 188,000,000 lb. from the following countries (in millions of pounds): United States, 82; Siam, 78; and Burma, 28. Total allocations of the International Emergency Food Council to be imported during 1949 are 298,000,000 lb.

Wholesale prices of domestic rice during 1949 have remained at a relatively high level. Although rice is the main food of 70% of the Philippine population, according to official data, the lower per capita consumption of rice is not necessarily indicative of an acute shortage of foodstuffs. In 1945 and 1946 the United States Army distributed a large volume of food among the population. Consumption of domestic root crops has been considerably higher than before the war, and imports of flour and several other foods almost double the pre-war average.

MALAYA

Malaya has for many years been dependent on imported rice to a greater extent than either Indonesia or the Philippines.

Since 1931 considerable efforts have been made to increase rice production, but although marked extensions of the area cultivated and rice produced have occurred, until 1941 they were offset by corresponding increases in imports. Since the war

imports have been much less than in the pre-war period.

Table 3 shows Malayan rice production in relation to imports and consumption. Present total consumption is abnormally low since imports are restricted.

Conditions under which rice is grown in Malaya are not dissimilar to those in Indonesia. In 1947-48 the total area grown was 844,000 acres in round figures, of which 764,000 acres was wet padi and 80,000 acres dry padi. In 1930 it was 657,000 acres, of which 630,000 was wet padi; the total production in that year was approximately 180,000 tons of rice, so that in the ten years before the war production nearly doubled. During the war production apparently fell despite the efforts of the Japanese to maintain it, although there are no figures available to show exactly what it was. Since the war it has recovered to approximately its pre-war position. The year 1949 saw a further extension in the area planted, which was estimated at 901,000 acres, but, unfortunately, owing to bad seasonal conditions, only 830,000 acres could be harvested, the remainder having been destroyed by floods or drought. The total production is estimated at about the same as the preceding year.

As in other parts of the south-eastern area of Asia high prices for rice have profoundly influenced the economic situation. The average declared trade value of imported rice for the three years 1946 to 1948, compared with the three pre-war years 1939, 1940 and 1941, were as follows:

Declared value in Straits dollars ($1.00 = 2*s.* 4*d.*) *per pikul of* 133⅓ *lb.*

1946	..	10.66	1939	..	3.75
1947	..	14.40	1940	..	4.74
1948	..	24.26	1941	..	6.54

This has affected the cost of production of export staples, particularly rubber, and also copra, coconut oil and palm oil, on which Malaya is largely dependent. Prices for coconut products and palm oil have risen greatly, although not entirely comparably with the rise in the cost of rice; on the other hand, the price of rubber—by far the most important agricultural export—as a result of competition with synthetic products, is at a level slightly below the pre-war value. As a result the economic situation and outlook is uncertain.

The Government Rice Cultivation Committee of 1931 drew attention to the dangers of too great dependence on export staples and advocated the extension of rice cultivation in order to lessen the dependence of the country on exports and the cogency of these considerations is again apparent.

Above and below: *Terraced rice fields in Garoet, Java. Conditions under which rice is grown in Java are not dissimilar to those prevailing in Malaya. Typical are the unirrigated wet fields on which rain water is conserved by means of bunds constructed by the cultivators*

[*Photos: Netherlands Embassy*

Compost in a Prison Camp

F. C. COOKE, A.R.C.S., B.Sc., A.M.I.Chem.E.

The following account of composting in a prisoner-of-war camp in Malaya shows how, under conditions of extreme difficulty, the composting of refuse was applied in producing supplies of vegetables necessary to safeguard health and prevent deficiency disease.

DURING the war it was my lot to be a guest of the Japanese for a very long period, during which the question of personal survival was the paramount consideration of us all. The need for growing vegetables became obvious as rations deteriorated and it was not long before small plots of land were being cultivated by enthusiastic gardeners. The supreme importance of concentrating on the vitamin-bearing, green-leaf vegetables was, however, at first appreciated only by a few.

In consequence, the state of health of the prisoners of war rapidly deteriorated. In a few months there was a severe outbreak of beri beri, followed by pellagra and other deficiency diseases. Of the many thousands who were taken prisoner few came through internment without experiencing deficiency diseases in greater or lesser degree.

Later it became apparent to the Japanese that an attack on Malaya by the Allied Forces was impending, and we were closely confined inside and around the walls of Changi prison. Very little land was available for cultivation and what there was was poor and impoverished. The soil ranged from a thin, loose sand to a yellow lateritic soil from which top soil had been removed by soil wash.

The gardeners began to apply human excreta, poultry droppings and raw kitchen waste direct to the soil, with the result that the fly menace quickly assumed serious proportions.

So it was that the writer came to be appointed Camp Compost Officer. His first duty was the suppression of unhygienic practices by the gardeners and his second was to organise the production of compost in such a way that the fly nuisance was almost completely suppressed.

It was necessary to exercise the strictest supervision over the camp kitchens and poultry runs and to introduce certain modifications into normal composting practice. Kitchen waste was sorted into covered bins, which were collected twice daily. It was also the duty of working parties to go outside the camp under armed guard to cut 'lalang' (*Imperata arundinacta*) for composting.

Building of compost heaps

The method of building the compost heaps was the usual one of layering the lalang, kitchen waste and poultry droppings with adequate daily watering to ensure maximum micro-biological activity. The materials were arranged in sequence of wet and dry, hard and soft, open- and close-textured material and the latter was evenly spread in thin layers to prevent the heap from developing dry pockets. The daily application of urinated water in a 1 : 4 dilution was a matter of experience; it was found that too much chilled the heap and too little delayed the process of decomposition. The amount required depended on the quantity of wet kitchen waste in the heap.

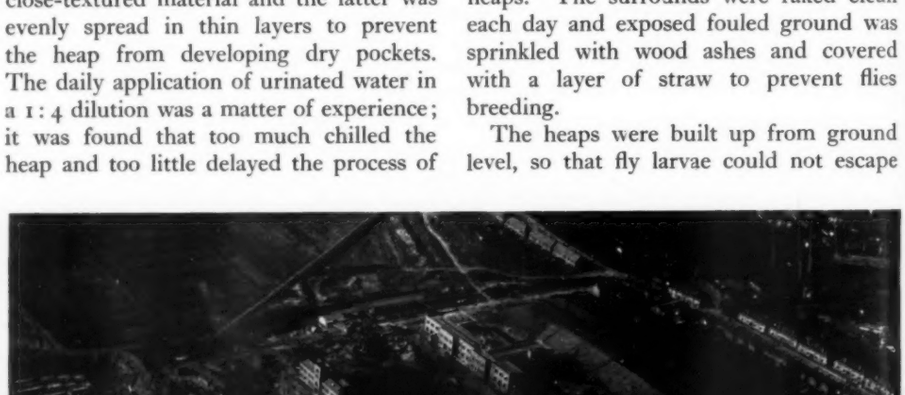
Human urine was perhaps the most important ingredient. The whole production of the camp was collected each day. A proportion was used for composting and the remainder for watering the camp gardens after dilution with water in the ratio 1 : 4; when urine is diluted it ceases to attract flies. In composting, the urine was either added with a slurry of wood ash or sprinkled in the form of urinated earth over layers of wet waste.

Certain modifications of normal composting practice were made to ensure the absence of fly-breeding in the heaps and surrounding ground.

Depot sites

The composting depots were sited on gentle-sloping land to allow the sour liquors to drain away from the base of the heaps. The surrounds were raked clean each day and exposed fouled ground was sprinkled with wood ashes and covered with a layer of straw to prevent flies breeding.

The heaps were built up from ground level, so that fly larvae could not escape



A view of Mogden Works, Twickenham, England, where sewage is processed into fertiliser

from the bottom of the heaps. Each heap was turned within ten days of laying down, and thrice more at ten-day intervals, *i.e.* within the life cycle of the fly. Most important of all, each heap was provided with a jacket of straw, consisting of four walls and a roof 1 ft. thick. This was intended to prevent flies from reaching the rotting waste and laying their eggs among the decomposing rubbish and ensured that the eggs previously laid would be destroyed.

The jacket protected the heap from rain, allowed free aeration and retained the heat within the heap on cold nights so that decomposition could proceed. The jacket of lallang was independent of the material composted and could be peeled off before the hot core was broken up and turned.

As a result, compost was produced in 45 days, which is half the time required by the normal process.

Production and rate of application

More than 500 tons of compost were produced in 14 months and applied periodically to 12 acres of land at the overall rate of 2 lb. per sq. ft. This was obtained from about 800 tons of kitchen waste, 200 tons of lallang, 32 tons of poultry droppings, 40 tons of urine and 16 tons of wood ash—a total of 1,088 tons. The addition of this 500 tons of compost to 12 acres of poor soil made it possible to grow 600 tons of vegetables for 5,000 men and so save many lives and prevent deficiency diseases.

Over 14 months each man received about 250 lb. of vegetables from these 12 acres of gardens at a cost of 20,000 man-hours of labour for compost preparation alone.

COMPOSTING FOR THE DISPOSAL OF SEWAGE AND REFUSE

The object of this book* is to record the author's pioneer work in converting into compost sewage and urban waste in the Union of South Africa. His success in this direction may be judged by the fact that the adoption of his system has become permanent in 110 municipalities in the Union, covering two-thirds of the urban population and producing 500,000 cub. yd. of compost annually, valued at £250,000. He has convinced municipal authorities in the Union of the value of this system and his book may be recommended to similar authorities elsewhere.

The author looks upon urban compost making as a means of reducing the cost of disposal rather than as a source of income and as a substitute for costly sewage schemes. Further research will probably result in a reduction of the cost of production by the elimination of some of the hand labour. For the rest, municipalities that dispose of their refuse by this method will reap the benefit by helping to maintain the soil in their areas in a state of high fertility.

The most important sections are those that treat of the utilisation of urban waste products and the details of urban compost experiments at Ficksburg. The method employed was based on the Indore system, using urban ' dust-bin ' waste with night soil or sludge. A clear plan shows the construction of the compost pit, illustrations of the work are interposed in the text and detailed instructions given of the technique employed. Labour requirements, cost of production and returns are briefly stated in a table, but the author might usefully have extended this to show the man-hours required for each step in production and included analyses of compost made under differing conditions.

Information is given concerning various aspects, including the incidence and control of flies, temperature studies, the influence of air temperatures on that of the compost pit and of rainfall on temperature. In a latter part of the book the author reviews the sources of organic manures within the Union, and two appendices by Mr. G. C. Dymond deal with sugar wastes and the use of the water hyacinth (*Eichhornia crassipes*) in sewage effluents as a trapper of salts and a water purifier.

The book is much interposed with reviews of literature which support the author's opinions regarding such questions as soil erosion and loss of fertility, the principles governing composting, urban centres and methods of waste treatment, and the importance of humus. One can agree with the author's conclusion that the needs of the plant, rather than those of the soil, have often been the primary consideration and have led to a decline in fertility. He appears to accept that the aim should be balanced farming, in which full use is made of all available organic matter, supplemented by artificials where necessary, and to this view one cannot take exception.

It is when the author holds up the East as an example to Western civilisation in the matter of soil conservation that one feels bound to take him to task. He would have one believe that ' soils in the East have been disturbed continuously for over 40 centuries without serious erosion having made its appearance yet,' a statement which is grossly misleading. The truth of the matter is that China has so denuded the land and misused the soil that the consequent soil erosion is her greatest problem. The vast majority of the population is therefore crowded in the valleys and on the flood plains of the great rivers, having been driven from the hills because they are so severely eroded that they are entirely unfit for cultivation. The consequent poverty of the Chinese farmer provides for us the lesson we can learn from 40 centuries of Chinese farming.

How can we use our sewage and our refuse? [1, 2]

In the first of these publications is traced the development of sewage disposal schemes, from the primitive to the most modern. The numerous schemes which have for their object ' disappearance at minimum cost ' result in an enormous waste of humus and fertiliser material. More modern installations, however, are so designed that improvements involving the reclamation of the end products can be undertaken. The history of such sewage disposal works is outlined and consideration given to the end products to render them suitable for disposal as fertiliser. The discussion of these problems leads to a consideration of the salvage of sludge from sewage. The treatment recommended is claimed to result in an odourless, dry and finely powdered product which is in growing demand among agriculturists.

Sludge and sewage

The composting of refuse with sludge or sewage is advocated, as the resultant compost not only contains plant nutrients, but also a rich culture of living micro-organisms and humic material which will improve the physical structure of the soil and encourage the maximum bacterial activity therein.

**Soil Fertility and Sewage.* By J. P. J. van Vuren. Faber & Faber Ltd., London, 1949, pp. XX & 236, 18s.

1 *How can we use our Sewage and our Refuse?* H. Martin-Leake. Publication No. 2, 24 pp. Price 5s.

2 *Municipal Composting.* L. P. Brunt. Publication No. 2a, supplement to No. 2 above, 8 pp. Price 2s. 6d.

Recovery of salts

Reference is made to the possible recovery of valuable salts from the effluent by the cultivation of the water hyacinth. The problem remains of finding an alternative plant which will withstand low temperatures.

Appendices give brief accounts of successful sewage and composting schemes operating in different parts of the world.

In *Municipal Composting* the materials to be composted are enumerated, and municipal composting procedure outlined, with special consideration of small depots for composting waste. Perhaps the most interesting section is that dealing with the mechanisation of municipal composting and the working of large installations. The conclusion is reached that, except where large regional sewage treatment works are already in existence, an appropriate application of the composting process can be devised for every local authority.

It is claimed for these publications that they are for ' the useful guidance of consulting and municipal engineers, local authorities and citizens who are interested in the utilisation of organic wastes.' It is doubtful, however, whether the information is sufficiently new or detailed to be of value to engineers. These pamphlets might have proved to be good propaganda among local authorities and citizens had they been published at a more modest sum than 7s. 6d. for a total of but 32 pages!

D. H. GRIST.

Progress in North Borneo

Surveying post-war changes in North Borneo, *The Times* special correspondent records a truly amazing recovery due to the dynamism of the Chinese (only one fifth of the total population of 335,000), an adequate rice ration, locally produced timber and generous Treasury help. There is no unrest and, as yet, no politics. There are many big developments on the way, including the damming of the Padas River to provide cheap electricity on the shores of Brunei Bay, and a port able to take ocean-going vessels. Another big scheme is the one for putting large areas under rice cultivation using mechanical methods. The shortage of labour remains and what the Government wants is good settlers rather than mere labour; Java appears to be the most promising source for these.

NATURAL VERSU

IN the editorial columns of our October issue we referred to the conference held in Malaya to discuss the question of the quality of natural rubber. This conference, which was held in Kuala Lumpur on September 13, was attended by representatives of the Malayan rubber planting industry, representatives of rubber marketing organisations, technical men and research workers from the principal rubber-producing countries in the East, who discussed ways and means to improve the quality of natural rubber, and the manner in which it is supplied to the manufacturer. In the course of discussions a full appreciation of the present competitive position of natural and synthetic rubber was made by Dr. E. M. McColm, whose hard-hitting statement is quoted in full below. Dr. McColm is the technical director of the Plantations Division of the United States Rubber Co. Ltd.

' The comments to which I have listened this morning,' said Dr. McColm, ' indicate that people here generally are unfamiliar with the method followed by the American rubber manufacturer in choosing the grades of rubber he purchases. Take, for example, the tyre division of any large manufacturer. His technical men have determined by many careful experiments just what grades of rubber are required in each of his tyres to produce the competitive quality required. Thus, for example, suppose it has been shown that the desired quality is obtained using Grade 4 smoked sheet, and that no economically worthwhile improvement can be obtained using a higher quality sheet. Suppose, further, it has been shown that the same quality tyre is obtained using an equal mixture of Grade 3 and Grade 5 smoked sheet, or of Grade 2 sheet and, say, Grade 3 brown crepe. The technical man, usually known as a compounder, charged with the job, is constantly following the price of rubber, and will order for use in that particular tyre the thus approved grade or combination of grades having the lowest average cost. His orders are ultimately collected in the hands of that company's crude rubber buying division, who merely execute them. This crude rubber buying division will generally have its own rubber inspectors who inspect a given sample of each purchase to insure that it meets the R.M.A. appearance specifications for the grade ordered and who will, of course, make a claim against any lot which is found not to meet these appearance specifications. But these are more or less by-products of the system, for in the final analysis it is the technical man who judges the rubber's performance and it is he who must be sold on the value of any improvement. Conversely, if he becomes sold because he has found that the improved rubber offers a monetary or quality advantage which justifies its purchase, then that company's buyer will get his orders and the new rubber will be purchased.

' Don't ever forget, therefore, that in the American market, at least, it is generally the technical man who is the final judge of what rubbers shall or shall not be purchased, and it is therefore the technical man whom you must convince of the value of any rubber offered for sale. The present system of visual grading is a superposition, useful only because of the lack of a grading system based on intrinsic properties.

' The proposals made at this meeting are being made for the purpose of providing a measure of technological information as to the intrinsic physical properties of each lot of rubber shipped from Malaya, and this information is aimed directly at the technical men who determine rubber buying policy.

Challenge of synthetics

' I believe it is important for you to realise just what you are up against in the matter of competition from synthetic rubber in order that you may be able to judge how important this matter is to your continued business life.

' In the final analysis, you are competing with the American synthetic chemical industry, a very competitive business which was suckled on our war needs in World War I, and weaned and attained manhood in the 1920s and 1930s in which hard, tough competition was the order of the day—every day, in every week, in every year. Out of this grew the competitive technique which is being used now to sell synthetic rubber. It involves intensive research by teams of chemists, physicists and engineers, and very careful attention to quality and to uniformity, combined with clever advertising. The watchword in the chemical industry is that he who cannot constantly improve his product, *and lower its cost*—mark that, *and lower its cost*—may not stay in business long.

' I am quite familiar with the type of research being done on synthetic rubber and with some of the men doing it. I can most gravely assure you that they are largely men who have grown up in this competitive atmosphere, and they are generously supplied with the competitive spirit. Their present goal is a product or

group of products which will equal or excel natural rubber in overall average quality. They are not anti-British or anti-Dutch or anti-French or anti-anybody or anything. They are not even anti-natural rubber. They are merely very pro-synthetic rubber. They are in a competitive game—if you like—with the quality of natural rubber as a goal. And, mark you also, they are not thinking about the premiums they may be able to charge for this improvement or that, but how to get these improvements at a lower cost!

Shortcomings of natural rubber industry

'Now contrast that picture with the condition of the natural rubber industry. Here you are still thinking in the pre-war groove where there was only one rubber —natural—and he who wanted it had to come to you to get it. Your selling technique, the open market, is as antiquated as the Ark and about as useless in the present war you have on your hands with synthetic. The synthetic research and development men regularly sit down with the rubber manufacturers' technical men to determine how synthetic rubber can be altered to better serve their needs. They are the real synthetic protagonists and salesmen. Yet you sit in your offices and wait for the American manufacturer to come to you to buy your product, and when he buys it he gets a commodity that is much dirtier than synthetic and nearly 100% more variable in most of its important physical and chemical properties, and therefore much more difficult to use in the modern, high-speed, stream-lined rubber factory which was geared during the war years to using a much less variable, and more high-temperature-resistant synthetic. True, it is still superior to the best synthetic in some properties — tensile strength, resilience and others—and it is that superiority which is the only reason why anyone still buys your product. Given equality, or even equality in some properties, and the choice, under present conditions, is likely to be synthetic every time.

'What have you done to date to meet this synthetic competition? Isn't it true that, outside of your research stations, you have done absolutely nothing other than to demand that America buy more natural rubber and less synthetic and at a higher price for natural? Why do you suppose that in 1948 America consumed about 170,000 tons more synthetic rubber than the legal mandatory requirement? Isn't it obvious that superior processing and technical quality had something to do with it?

'The proposals made at this meeting are to the effect that you begin to do something about this situation by indicating two important characteristics of each lot of rubber shipped, namely rate of cure and plasticity. Although this is admittedly only a beginning, it is at least something, and will enable the buyer to reduce very markedly his operating difficulties, which are due to variability. Even more important, it will indicate to him that you are prepared to do something about quality, and are actually doing it!

'So far, at this meeting, all I have heard has been why these proposals couldn't be put into effect. Do you suppose we in America created and built a synthetic rubber industry in time to help win a war by thinking up all the reasons why it couldn't be done? I tell you that it's time we in Malaya realised we are in a serious war with synthetic rubber, and that we now have no time to waste in devising ways by which we can't do anything about quality. For it is my considered opinion that if we ride along as we are doing now, paying no attention to the variability of rubber or to improving its quality, we may easily be out of business within ten years.

'I am convinced that we here in Malaya have just as much ingenuity, and just as hot a spark, as the people who created the synthetic rubber industry. But we can't let the research stations do it alone, for it will take the wholehearted co-operation of the planter, large and small, the dealer, the broker and the exporter.

'I would therefore suggest that this meeting form itself into a permanent organisation to further the improvement in the quality of natural rubber; that as a first step it appoint a committee to investigate and determine how a certification scheme can best be set up, and a second committee of business men charged with finding the necessary funds and getting it going.'

World Dried Apple Production Lower

THE 1949 preliminary estimate of dried apple production in the five leading commercial producing countries is 12,100 short tons, compared with 10,800 tons (revised) in 1948 and 20,200 tons in 1947. The estimate is about 47% below the ten-year (1938-47) average of 23,000 tons and 44% below the five-year (1943-47) average of 21,600 tons. The preliminary estimate for the United States, based on information of trade sources, is 9,500 tons which, while above that of last year, is less than half the pre-war average and less than one third of the all-time record of 34,000 tons in 1928. Production estimated for Australia and Canada are down from those of a year ago. No change is reported in production for New Zealand and the Union of South Africa.

Australia

The production of dried apples in Australia was down about one third from that of the previous year, primarily because of the small fresh apple crop in Tasmania. The production of dried apples in Tasmania, usually about 90% of the country's total, was the smallest in some years. Dried apples are produced on a small scale in South and Western Australia. The dried apple pack in Australia in normal times usually is sold mostly in the domestic market. During the war when the exportation of fresh apples was suspended, the production of dried apples was greatly increased. The exportation of dried apples increased from 88 tons in 1938-39 to 1,038 tons in 1946-47. During the 1948 season exports totalled 1,026 short tons.

Production of dried apples from 1920 to 1939 reached about 500 short tons. In 1940, production increased to 600 tons and reached an all-time high of 2,300 tons in 1944. It is probable that production will decline gradually in the years ahead as fresh fruit exports increase.

During the 1949 export season to July 1, 108,144 lb. were exported at a value of £8,957 (about 27 U.S. cents per lb.). Sweden was the principal destination with 70,280 lb. Egypt and Jamaica both purchased 11,000 lb., and the balance was exported to other British areas, mostly in the South Pacific. Exports for the balance of the season are expected to be very light. The bulk of this year's pack will be consumed in the domestic market.

The Storage of Potatoes and Grain*

IF potatoes are to keep well during storage they must be free from disease and should, if possible, go into the clamp or store dry. They may be lifted for storage as soon as the skin is tough enough to resist rubbing. In districts where drought has been severe, crops ripen prematurely, and nothing is gained by leaving them unlifted until the usual time. Sprouting will have already occurred to some extent and would be accentuated by additional moisture and high temperatures. Droughts are usually followed by heavy autumn rains and, although it takes much rain to make typical potato soils really messy, some of the heavier soils on which potatoes have, of necessity, been grown become almost unworkable in wet weather. The longer potatoes are left in the ground after they are ready for lifting the greater is the likelihood of wastage from disease. When clean tubers, free from disease, are clamped or otherwise stored in dry condition, allowed to sweat properly before earthing over or not piled too deep in sheds, there is not, as a rule, much storage trouble—always, of course, provided the tubers are protected adequately from rain and frost.

In a warm autumn greater precautions must be taken to avoid over-heating than in a cool one; lack of ventilation and consequent heating commonly leads to wet rot. The chief cause, however, of wastage during storage is blight. Infected tubers should not be stored with sound ones; they should be kept separate and boiled or steamed for stock-feeding. Sound tubers may become infected at lifting time by spores from blight spots on the foliage. It is to guard against this form of infection that haulm is destroyed by sulphuric acid some ten days before lifting.

But most of the potatoes grown are not sprayed, and it is therefore important to adopt other means of safeguarding the crop. There is this to be said to non-sprayers: Blight spots on leaves tend to dry up in fine weather and do not spore freely. Also, to be infected, tubers must remain moist for some time. Much can be done, therefore, to reduce blight in the tubers to the minimum if lifting is done in fine, dry weather, when conditions are favourable for quick drying. There is no evidence that blight spreads from diseased tubers to sound ones. Infected tubers, however, are attacked by wet rot, and this spreads to sound ones, with danger of overheating and collapse. Moisture always favours the development of soft rots, and it is largely for this reason that the crop should be stored dry.

Another source of wastage is mechanical damage. Some such damage is practically unavoidable, but it should be minimised at all stages—lifting, clamping and subsequent handling for disposal. Tubers should not be thrown about or trampled by hob-nailed boots. The effects not only prejudice disposal for domestic purposes, but the organisms responsible for dry rot, being mainly wound parasites, readily gain entrance through broken surfaces. Harrowings, owing to their rough handling, are particularly prone to attack and should always be kept separate.

Storage outdoors in clamps is quite satisfactory when done well, but it is usually far more convenient and comfortable (and at least equally satisfactory) to store in well-ventilated, frost-proof sheds. The potatoes keep well, they are always dry, they can be dressed and delivered practically regardless of weather and, with artificial light, workers can put in a full day. For the small acreages of new growers, straw-lined loose boxes or similar accommodation will serve. Up to 5 ft. is a safe depth for most varieties fairly mature, clean and dry. For less mature potatoes or earlies 3ft. will generally be enough. A covering of straw prevents moisture condensing on the top tubers and trickling down to dampen the heap and it also, of course, prevents greening.

Care of stored grain

The ideal at which to aim in storing grain is that the grain should be in as good a condition at the end of storage as at the beginning. To achieve this, several important points must be watched.

(1) For bulk storage, grain should be dried to 16% moisture content or less under hot and dry climatic conditions.
(2) The storage place (silo, barn, etc.) should be thoroughly clean before grain is stored. All sweepings and residues should be removed.
(3) The storage should be rodent-proof.
(4) Bagged grain should never stand on a concrete floor—use wood dunnage to lift at least 4 in.—and should be clear of walls and roof (a 2-ft. alleyway is enough).
(5) Freedom from damp is essential, also there must be adequate ventilation. Buildings should be kept kept in a good state of repair.

When grain begins heating it is a definite sign that something is wrong and if not checked it may lead to serious damage.

Damp grain heating may occur if the initial moisture content is over 16%. It is brought about by moulds, and may result in the grain becoming caked, matted and musty. Dry grain heating is brought about by insect activity inside the bulk. Starting with local ' hot spots,' the rise in temperature will, if not checked, spread throughout the bulk. The presence of holed or hol-

An American State grain mill and storage

* Ministry of Agriculture News Bulletin No. 526.

lowed grains is a definite sign of insect activity.

Insects commonly attacking stored grain include grain weevils, grain beetles and moths. Mites may also be found, particularly when grain is not thoroughly dried. The grain weevil lays its eggs just beneath the seed-coat of the grain; the larvae develop inside the grains and will not be seen. After pupation the adult emerges from the grain, which clearly shows the exit tunnel (holed grain). Grain beetles and their larvae are free-living and damage the grain from the outside. Moth larvae damage grain by eating and also by the deposition of webbing, which can cause caking.

(1) Ensure that grain goes only into clean storage places.
(2) See that initial moisture content is not more than 16%.
(3) Inspect at weekly intervals, and take action at once if the temperature rises steadily over a period of two weeks. Use a reliable thermometer mounted on a pointed stick, and take readings at a depth of 2 ft. over various parts of the bulk.
(4) Take action the moment insects are seen or suspected.
(5) An infestation may be controlled by passing through an agricultural drier —the grain should reach a temperature of 120 to 140°F.
(6) In extreme cases of infestation expert advice should be sought, as fumigation may be necessary.
(7) Empty structures, to be used for grain storage, may be treated with insecticides before use. These can be in the form of dusts (B.H.C. or D.D.T.), smokes (B.H.C. or D.D.T.) or sprays. Suitable sprays are 1.3% pyrethrins in oil, B.H.C. (0.5% gamma B.H.C.) or D.D.T. (5%) in oil, and B.H.C. or D.D.T. water-dispersible powders. These insecticides are readily available from dealers.
(8) Small parcels of infested grain or empty infested sacks may be fumigated with a mixture of ethylene dichloride and carbon tetrachloride.
(9) When in doubt, call in an expert.

Appointments

The Colonial Office announces that **Mr. O. J. Voelker, C.B.E.,** Director, The West African Cocoa Research Institute at Tafo, Gold Coast, has been appointed to the vacant post of Director of Agriculture, Malaya. Mr. Voelker will be succeeded at Tafo by **Mr. J. West,** who holds the post of Chief Scientific Officer on the staff of the West African Cocoa Research Institute.

When the clove buds are ready for harvest—that is, just before they burst into flower—they are a beautiful apple green tinged with pink

Sudden Death Disease of Cloves in Zanzibar

FOR many years past a disease of clove trees known locally as Sudden Death has caused anxiety. Of late years its spread has become intensified; now half the clove fields on Zanzibar Island are already dead and the disease is spreading rapidly in the adjacent island of Pemba, which produces more than three fourths of the clove crop of the Protectorate.

It has recently been stated that if the disease is allowed to spread to the same extent in Pemba as it has in Zanzibar the economic ruin of the industry is probable.

A clove research scheme was set up in 1946 to trace the cause of the disease and to find remedies if possible. It is considered that so far as Zanzibar is concerned the only possible action is to allow the disease to run its course and to replant devastated areas with other crops before replanting the clove trees.

A plan has been proposed for controlling the disease on Pemba, which consists essentially of cutting out all trees known to be infected as well as those immediately in contact with them, destroying them by burning, clearing all surrounding vegetation and spraying them with a powerful insecticide to kill the insect vector and the ant which transports and tends them. It is considered that this will involve cutting out about 60,000 trees.

Areas on which trees have been destroyed would be planted in food crops for two years before the cloves are replanted.

To secure the co-operation of growers and to compensate them for the loss involved it is proposed to make cash payments to farmers equal to the estimated average profit from the trees which would be removed and will assist in replantation. Payments would extend over a ten-year period, by the end of which time newly planted trees would have reached the bearing stage.

Zanzibar and Pemba supply the major portion of the world supplies of cloves, Madagascar being the next most important source.

Wealth in Forest Development

Millions of exotic pine trees, thickly clothing once-desolate pumice country in the central portion of the North Island of New Zealand, today represent the Dominion's new-found wealth. They cover roughly 850,000 acres, half of which are owned by the State and half by private companies. Within a few years these vast man-made forests promise to yield £20,000,000 per annum to the country and will rank second only to dairy production as its greatest money-spinner.

Near the heart of the pine plantations. Pumice formation is clearly seen in the foreground

LIKE most countries, New Zealand only comparatively recently awoke to the appalling consequences of the indiscriminate cutting and milling of her native forests, which had been proceeding for a lengthy period. Within 100 years, by prodigal use of fire and axe, the indigenous forest areas had been reduced from some 27½ million acres to about 12 million and her most valuable timber species—kauri and kahikatea—had been almost eliminated from commercial use.

Some 30 years ago, however, men of foresight saw the writing on the wall and initiated a nation-wide campaign for planting exotic trees, mostly *Pinus insignis*. It was amazingly successful. The trees flourished on barren soil useless for agriculture and reached maturity in 20 years. They do better in New Zealand, in fact, than on their native soil in Europe and America.

Whereas New Zealand had formerly squandered her timber wealth, she is now farming it, for the crops are perpetual, and these exotic forests, which are now growing at the rate of 10,000 tons every day, have already resulted in the establishment of valuable new industries.

As the largest owner of exotic forests in New Zealand the Government is looking ahead in an effort to utilise 300,000 acres of rapidly-growing trees. It recently consulted experts from England and the United States and will shortly announce a vast programme for converting matured trees into useful by-products, estimated to involve the expenditure of some £14,000,000. The scheme envisages a great increase in the export of sawn timber —mainly to Australia—and the establishment of a large newsprint mill capable of meeting New Zealand's requirements and with a margin for export to Australia.

Two private companies—N.Z. Forest Products Ltd. and Whakatane Board Mills Ltd.—own practically all the remainder of the Dominion's softwoods forests. The former has about 176,000 acres planted and the latter about 62,000 acres. At present the state is only now entering the marketing phase, but both these companies mentioned are well advanced in research, manufacturing and utilisation generally.

The opinion is widely held that as both the Government and private interests are equally interested in making the best use of the forests there should be full co-operation between both sets of interests.

Some concern has been expressed recently about the provisions of the Forestry Bill before Parliament, which places overall control of all forests in the hands of a Minister of the Crown, but any fears concerning the nationalisation of

the industry were allayed by a Government denial that any such step is contemplated. It is still felt, however, that the interests of both state and private afforestation and forest utilisation could best be served by the exercise of control through an advisory board comprising representatives of all interests.

N.Z. Forest Products Ltd. is now the premier timber milling and utilisation enterprise in the southern hemisphere and is on the eve of large expansion. Its total authorised capital is £11,000,000, its paid capital £6,200,000 and its forest assets alone are valued at over £5,300,000.

Twelve years ago the company assumed charge of the plantation and operations in accordance with modern scientific practice were commenced, including sustained yield and selective logging.

From the start of its utilisation programme in 1941 the company has cut timber on 5,000 acres, during which period timber supplies have increased by natural growth by several times the quantity used.

Commencing with a wallboard mill which shipped overseas about 60,000 tons of board for military purposes, expansion has proceeded rapidly. This mill cuts some 1,500 acres a year and employs 750 workers, whose numbers will soon be doubled. It has the largest railway freight and electric power bills of any industries in the Auckland province and it has exported as far afield as South Africa, India and China.

The company manufactures more than 1,500,000 cases and shooks annually for the packaging industries and more than 5,000,000 multiwall paper bags a year. Its wallboard output is unable to satisfy even domestic needs fully and extensions to the plant are projected. Its exports of sawn timber and fibre board swelled to three times those of 1947-48 and turnover generally increased 47%.

Within the next three years the company will spend £4,000,000 on works which include sawmills to cut 60,000,000 ft. of timber, chemical pulp mills (the first in New Zealand) to produce 25,000 tons annually, a kraft paper mill to manufacture 10,000 tons annually and a corrugated container factory and extensions to the wallboard mill, including the manufacture of tiled and tempered hardboard.

Immediate further uses for New Zealand exotics embrace chemical pulp mills, manufacture of newsprint, printing and writing papers, pulp for artificial silk production in New Zealand or Australia, as well as sawn timber for export.

The development of the tyre industries in both New Zealand and Australia will call for substantial supplies of rayon, while the newsprint demand in both countries will be able to absorb 250,000 tons per annum.

' Wet strength ' paper, which has stood up to remarkable tests for durability, is also to be investigated in relation to the use of *Pinus insignis*, while conversion of softwood to hardwood is another avenue which may eventually occupy attention.

From all this it can be seen that the programme of forest realisation is only beginning to approach the desired goals, and its full potential is as yet unmeasured.

The state and private enterprise are equally interested in protecting and harvesting the forest wealth of the Dominion and, apart from utilisation, the forests perform an invaluable function in clothing and protecting lands which were formerly barren pumice wastes, and in halting erosion and soil denudation which have produced so much loss in the past.

Above: *An aerial view of some of the 120 million trees that stand ready to yield their wealth*
Below: *Wide fire-breaks help to protect the 800,000 acres of forests. Shown here are* Pinus Radiator *trees which can be pulped for wallboard and Kraft paper in 20-25 years*

Britain's Battle for Food

At a meeting of the Royal Society of Arts in November last, Sir James Turner, President of the National Farmers' Union, reviewed, from the point of view of the practising farmer, the outlook for British farming, having regard to the need for producing as large a proportion as possible of Britain's food supply from domestic sources.

We reproduce below a summary of Sir James Turner's important paper.

WE are at this moment in the thick of the third battle for food in the short space of 35 years. The two previous campaigns had no greater significance to the social and economic survival of Britain than has the present one, except that they were part of the grand strategy of physical warfare.

The present battle for food, while it is no less grave in its social and economic implications, is not followed in its course with the same degree of national anxiety because it lacks the more obvious threats of physical warfare to drive home the consequences of failure. While we are being artificially sustained by Marshall Aid in the procurement of a large part of our food supply from overseas, we are just as artifically protected by taxation at home against the full impact of food prices. The effect is to hide from the people the imminence of danger to our daily bread.

We certainly need a clearly defined goal and a healthy fear of the consequences of failure to permeate the whole country if we are to avoid economic disaster. The issue turns upon our ability to procure the difference between what is needed for a full and varied diet for 50,000,000 people and what we can produce for ourselves from our diminishing area of agricultural land. After Marshall Aid ceases in 1952, this gap in our food requirements can only be filled from other countries by the goods and services we sell abroad. The battle for food, then, is being fought to reduce by home production the margin of our dependence on overseas currencies and supplies.

Of Britain's food imports before the war at least £200 million worth every year came to us as interests on overseas investments. They were very largely liquidated in winning the war. To a large extent, therefore, increased investment in, and increased output from, home agriculture is a replacement of the loss of British capital in many parts of the world. Add to this the fact that our visible exports have been falling since the beginning of the century, and not just since the beginning of the last war, and we begin to recognise that the battle for food becomes the battle of a very much bigger gap in trade and production than is represented by the ravages of the last ten years.

The table of figures printed in the next column give the story of Britain's declining export trade.

	Volume of exports (1913 = 100)	*U.K. exports as a percentage of world exports*
1913 ..	100	13.11
1924 ..	80	12.94
1929 ..	87	10.96
1932 ..	54	9.92
1937 ..	72	9.87

In 1934 the nation's retail food bill was £1,075 million, and food prices 22% above 1914; but other items in the family budget (*e.g.* rent, clothing, etc.) were 70% above 1914. This increase of 70% reflected increased costs of production. If food prices had been 70 instead of 22% above 1914 levels, the nation would have paid well over £400 million more for its food in 1934 than it actually did. In contrast to this £400 million, financial assistance to farming in 1934 amounted to £15 million, although, as compared with 1914, labour costs alone in farming had increased by well over 100%.

In pre-war days food prices were kept low, and primary producers impoverished, by *laisser-faire* economics. In war-time the tradition of food prices being lower than other prices was continued as a matter of policy and is still maintained by means of subsidies to the consumer. We should not forget that the present system of subsidising food prices out of taxation is merely the pre-war position in reverse.

The following table gives a comparison between the value of certain commodities paid for by Marshall Aid and the U.K.'s total imports of these commodities in the first year of the European Recovery Programme (April 4, 1948, to March 31, 1949):

Commodity	*Value of total imports** £ million	*Value of Marshall Aid imports** £ million	*% financed by Marshall Aid*
Bacon ..	23.5	12.8	54.5
Wheat ..	101.7	63.5	62.4
Flour ..	25.4	15.1	59.4
Cheese ..	30.4	10.2	33.6
Sugar ..	61.8	7.4	12.0

The gap is further illustrated by the decreases in the quantities of imports of certain essential foodstuffs in 1948 as compared with 1938. The following are some outstanding examples:

Commodity	*Decrease* %
Grain and flour	23.9
Meat (including bacon) ..	27.2
Butter	42.7
Shell eggs	44.2
Lard	86.1

We must remember that we have at least 2,000,000 more people to sustain, so that the position is actually worse than even these figures indicate.

There are still many people who imagine that by some turn of the wheel of fortune we shall again be able to command bargain-priced food. Such people are deluding themselves by believing that exporting nations are going, of their own volition, to sell at less than the cost of production. Wanton exploitation of the primary producer could only weaken still further our position; prospective markets would dry up for lack of that purchasing power on which British overseas trade now mainly depends. By the same token, food producers would be equally foolish to try to exploit consumer markets, because this would merely result in a shrinkage of those markets and a lower gross return to farmers.

Before the war we produced 30% of our food. In 1940 we had advanced by only 2% towards greater self-sufficiency, but by 1944 we were producing 44% of our rationed food supply. We are now engaged in the Agricultural Expansion Programme, and the task set is the production of 50% of Britain's food needs by 1952.

We are engaged with the Government in an intensive survey of the potentialities of our production effort to determine how it can be geared to the quickly changing circumstances. This is the first time there has been a joint appraisal of what is practical within the bounds of good husbandry. We need an imaginative approach if we

*These figures are not strictly comparable, since total U.K. imports are valued on a c.i.f. basis, whereas Marshall Aid imports are valued f.o.b. To that extent, however, they are an under-statement.

are to achieve a revolution in the traditional methods of farming and, while there are few technical obstacles, economic realities must be recognised. They include capital investment and the re-equipment of vast farming areas in this country for their new tasks. They also demand that production policy shall remain constant for a long period.

It is inevitable that inequalities will occur in the process of agricultural development. It would be a miracle if every farm was producing from the top shelf of efficiency; we all recognise that the country simply cannot afford inefficient production and the greatest care must be taken to create the conditions under which full efficiency can be achieved.

It always sounds strange in townsmen's ears that we cannot change over to new lines of production that happen to come into strong demand, but it is only at considerable risk to the fertility of the soil, and at considerable expense, that farming practice can be suddenly turned to meet a particular emergency.

The deliberate and untimely shrinkage of the agricultural land of this country can hardly be considered a convincing demonstration of the way in which we should treasure our fertile acres. According to Prof. Dudley Stamp, in the nine years ended June 1947, the net loss of open land was roughly 50,000 acres a year, five sixths of it improved, and mostly good, farmland.

In recent years British agriculture has become one of the most highly mechanised in the world. Whereas, in 1939, there were only about 50,000 tractors in England and Wales, the number was five times as great at the end of 1948. There were also, in 1948, over 48,000 milking machines in use and nearly 5,000 combine harvesters. And these figures are on a rapid up-trend in 1949.

The following figures, which show the average weekly movement off farms of cereals and potatoes and the average monthly movement of milk, give some idea of the expansion in home production:

	Pre-war	1948
Wheat (in thous. of tons)	14.0	23.9
Barley ,, ,,	10.1	23.8
Oats ,, ,,	2.27	4.51
Potatoes ,, ,,	59.8	107.8
Milk (in millions of gal.)	104.1	134.8

The maintenance of livestock numbers has been severely hampered by a shortage of imported feeding-stuffs. Whereas roughly $8\frac{3}{4}$ million tons of feed were imported in 1938, only about $4\frac{1}{2}$ million tons were imported in 1948. Despite this, the number of cattle in England and Wales has risen from 6,770,000 in June 1939 to 7,680,000 in June 1949. Moreover, the number of poultry of all kinds has increased from 56,426,000 in 1939 to 60,975,000 in June 1949. The number of pigs, however, reflected the severe shortage of animal feed. In June 1947 there were only 1,146,000 pigs as compared with 3,515,000 in 1939; but as the Agricultural Expansion Programme got under way, the number of pigs rose to 2,120,000 in June 1949. Similarly, the number of sheep and lambs rose from 10,162,000 in 1947 (pre-war nearly 18,000,000) to 11,724,000 in 1949.

The extent of increased production is considerable, but it is by no means the end of the effort and, even when we have achieved the level of production set for 1952, we shall claim no more than having reached the lowest level that ought to be maintained in this country for security and economic reasons. That we can vastly increase the volume of livestock and livestock products is generally recognised, and, if the sterling problem did not throw upon our farms the onus of growing such huge quantities of grain for direct human consumption, our capacity to provide meat and milk, eggs and bacon, would considerably reduce our expenditure of foreign currencies. By importing feeding-stuffs with a high value of conversion into livestock products, we should avoid many overseas purchases of those products at a higher comparable price and augment and release the fertility of our own soil to stimulate more production.

The marginal land problem presents a formidable task primarily because, during years of neglect of agriculture, reversion to rough grazing was the sequel to retrenchment. Much of this has a potential productive capacity immeasurably greater than its output today, if measures could be taken to tap that potential. Such measures involve much greater initial capital expenditure and a new source of capital investment is therefore indicated. The provision of roads, water supplies, housing, etc., cannot be undertaken by an undercapitalised landowner or owner-occupier, and hundreds of thousands of acres of potentially good agricultural land lack the essential capital equipment to which I have referred. At this time, when the curtailment of capital investment is being advocated as part of national retrenchment, it would be an example of folly if it perpetuated the restriction of development of our national resources.

Another important factor is the need to extend rural water supplies. Only 37% of the farm buildings in England and Wales have a piped water supply. A good water supply to fields is also essential if livestock are to be kept in any numbers, but only 16% of all holdings in England and Wales have such a supply; 42% rely on streams and rivers, 29% have 'other' sources of supply and 13% have none.

(*continued overleaf*)

A tragic outcome of the economy measures introduced by the Government is that they threaten curtailment of capital investment in rural electrification—one of the most essential instruments for the economic development of our farms. Potential output will be affected very seriously by this decision and I trust wiser counsels will prevail.

This is the time for Britain to look facts in the face, neither shirking the issue nor shrinking from the remedies. The analysis of the problem should be objective and realistic, and the solution made practical and effective by a re-assessment of priorities. A clear assessment of the position would be a spur to greater endeavour. Agriculture, with no mean record behind it, is anxious to make its maximum contribution by progressively raising its output and efficiency. Its people are practical and well organised, they know what can be done and what is needed to secure the results; they will adjust and adapt production, within the bounds of modern good husbandry technique, to the national needs. They will meet short-term requirements and put up with irritating changes of emphasis provided they have confidence in the soundness of the long-term plan, for without this the peak of efficiency cannot be reached. British agricultural development means a growing, rather than a wasting, asset and represents above all an investment in expanding production, in home purchasing power, in fuller employment and greater economic security for the people.

Land Colonisation in Jalisco, Mexico

FIVE years ago the government of the state of Jalisco, in west-central Mexico, began a programme of land colonisation to expand the agricultural production of the state. Within the past two years the programme has progressed substantially. Part of the financing has been done by the Government of Mexico. In 1948 nearly 25,000 acres of new land were opened for cultivation, and this year an additional 37,000 acres are expected to be ready, bringing the total acreage of land farmed in the area to 125,000.

It is the objective that about 250,000 acres of new land can be put into cultivation. Before this goal can be reached, however, mechanisation must be introduced, irrigation facilities must be increased and roads must be built and improved.

The south-western part of the state contains heavily-timbered mountains, fertile sub-tropical valleys, and tropical lowlands along the Pacific coast. This region is almost entirely agricultural. Corn, beans, rice, sesame, pineapple, coconut palms, sugar cane, tobacco, bananas and garden vegetables are the principal crops. Two crops of corn, rice and beans are grown a year. There is also some lumbering and hunting and fishing in certain parts of the area. Livestock is abundant in the region but generally is of poor quality.

About 30% of the arable land is owned by small farmers, 20% by ejidatarios—individuals to whom the Government has given 20 to 40 acres of land—and about 50% is controlled by 16 haciendas—an estate exceeding 2,400 acres. Titles to most of these haciendas have been handed down from Spanish colonial times. From the Mexican Revolution until a few years ago, agricultural output on most of the haciendas was very low. But when the owners got ' Certificates of Inaffectability,' guaranteeing that their lands would not be taken for distribution to tenants, production increased considerably. Mechanised agriculture has been introduced on several of the haciendas recently.

Extracted from ' Foreign Agriculture,' Vol. XIII, No. 10, published by the United States Department of Agriculture.

Nature of land

The land of the region is fertile and the climate tropical. Under these conditions, plant growth is heavy and cultivation must be intense. Land on which corn is harvested will be overgrown with brush and weeds several feet high less than three months later. It is evident that without further mechanisation little progress can be made in opening new land and keeping it under cultivation. But much of the land now being farmed is still covered with stumps that would have to be removed.

At present, there are only about 60 tractors in operation in the region, and the farmers estimate that one tractor is needed for every 370 acres. Those farmers who do have mechanical equipment find it difficult to get competent operators and breakdowns are frequent. Furthermore, there are no repair shops available. Small landowners complain that agricultural implement dealers do not provide liberal credit terms or sufficient instruction on how to use mechanised equipment. One tractor dealer in Guadalajara, however, has offered better terms than the others and has been able to sell his product by providing instruction and servicing. Most of the small farmers now use oxen to pull the ploughs, and they sow the seed by hand.

There is a shortage of labour in the area. Farmers cannot get enough workers and most of those they do get will not work hard or stay long.

In addition to mechanised agriculture, south-western Jalisco must have modern irrigation methods before its land can be fully developed. During the rainy season, from June until September, the many mountain streams provide sufficient water for the crops. There are a few storage dams in the area now that provide water for irrigation during the dry season, but more will have to be built. The Government has constructed several canals to prevent the fields from being flooded during heavy rains.

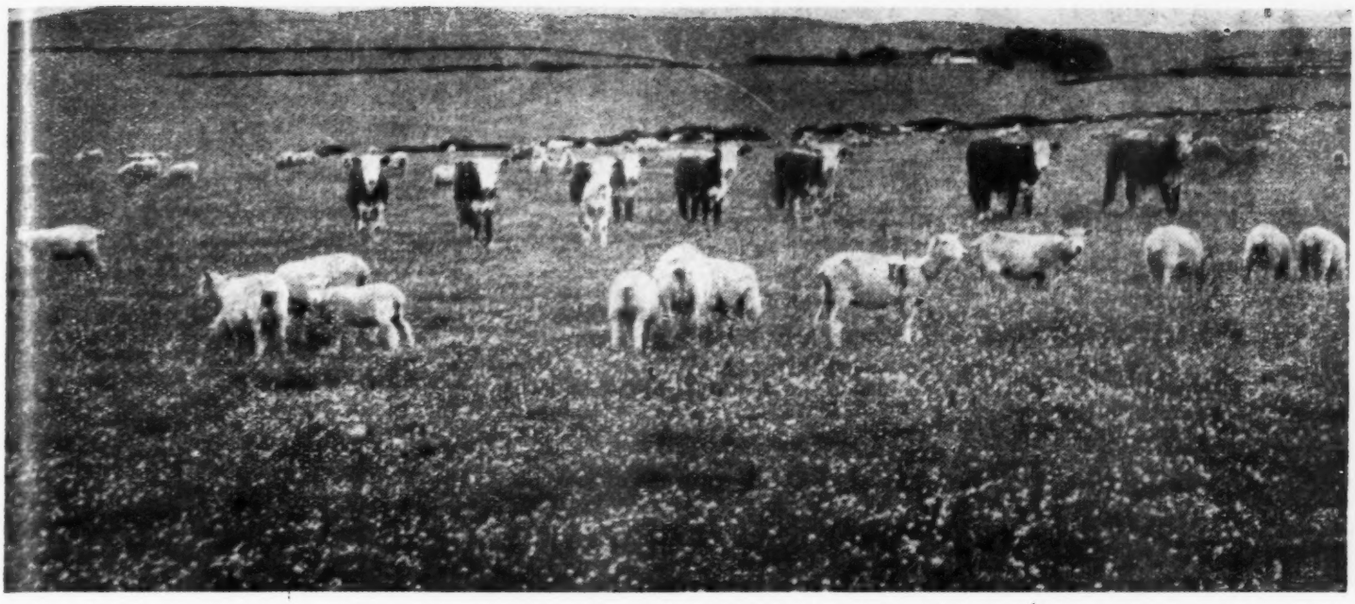
Another problem that must be overcome is that of transportation and communication. The state government realises this, and began several years ago to extend and improve some of the roads.

Timber Development in Tanganyika

Said to compare favourably with Burma teak, mvule is being developed in Southern Tanganyika by Messrs. Steel Brothers—well-known handlers of Burma teak for many years. They are investing £250,000 sterling in developing 250,000 tons of fine timber in a 20-year programme.

The firm is supplying all the capital and running expenses, while the Government is foregoing royalties but receiving an equal share of the profits.

Timber will be exported by railway to Lindi from the company's headquarters 20 miles to the north. The company is co-operating with the Forest Department in replanting schemes which are proceeding alongside tree-felling.



White clover is an important constituent of pastures throughout New Zealand. In suitable districts, such as Canterbury, it is used for both seed production and grazing

Production of White Clover Seed in New Zealand

C. C. LEITCH

Department of Agriculture, Christchurch, New Zealand

New Zealand has of late years come to the fore as a producer of seed for sowing down pastures. The most important is white clover, in which a considerable industry has grown up. The ability of white clover to grow on a wide range of soil types makes it a particularly valuable constituent of seed mixtures, while its response to dressings of phosphatic fertiliser and its ability to consume nitrogen from the air make it an ideal plant for pasture improvement programmes under temperate conditions. The following account of the industry has been taken from a recent article in the 'New Zealand Journal of Agriculture.'

THE characteristics of white clover (*Trifolium repens*) are overground runners which root at the nodes to form new plants, hairless leaves and steams, and short stipules. The large-leafed form is sometimes confused with red clover, but they can be distinguished readily by the hairiness of red clover. Strawberry clover is very similar to white clover, but differs in that the leaflets are dark green and oval. White clover can be distinguished readily from alsike clover by its shorter stipules.

Seed and plant

The seed is heart-shaped and it can pass through cattle uninjured and germinate freely in the dung. The plant is a perennial, and its ability to spread by means of the runners makes it very valuable in any field, because it soon fills up the bare spaces and gives a good cover to the soil.

White clover has a most important place in New Zealand farming. It is the keystone on which pastoral production in New Zealand is based, and in its absence difficulty is experienced in keeping up production. Because of its ability to grow under a wide range of conditions it is included in almost all seed mixtures for both plains and hills in most parts of the country. Being a legume, it is able to increase the nitrogen content of the soil.

Conditions which are not suitable for its growth are those on undrained swamps, very light shingly soils and soils of very low fertility.

History of seed production

White clover seed has been harvested in New Zealand for 60 to 70 years, but from figures available it would seem that for some years the acreage harvested ranged between 2,000 and 3,000 for the whole country. This can be accounted for by the fact that white clover seed could be imported at a price to compete with the locally-grown product, and farmers were not aware of the great benefits to be derived from the use of an approved strain of white clover in their pastures.

The saving of white clover seed has been

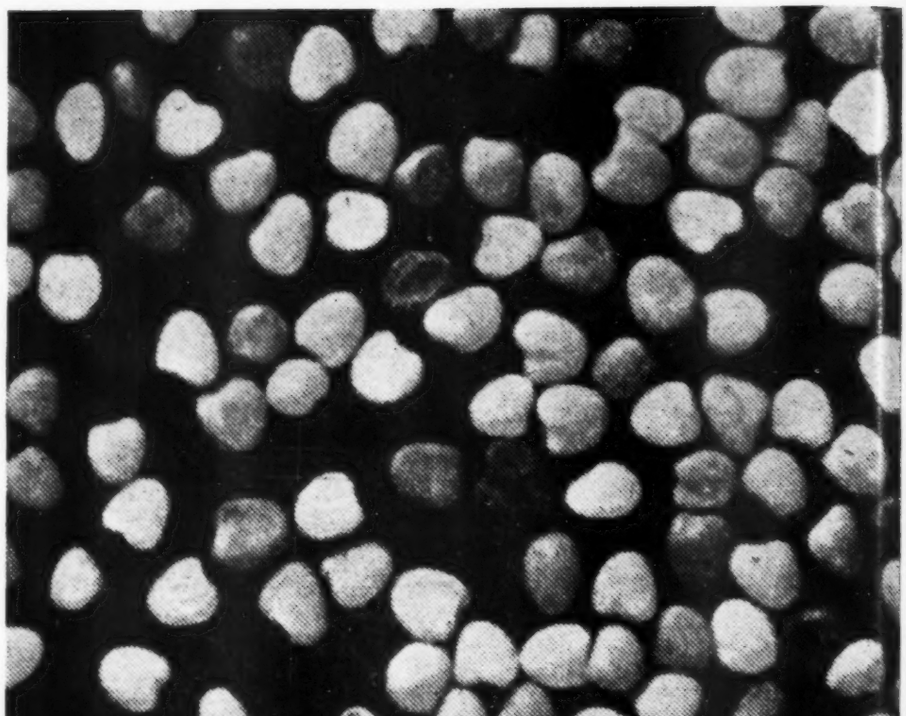
revolutionised in recent years. With a widening appreciation of its value in a mixture, the demand for seed in New Zealand has increased, and the export market has also developed, particularly for certified seed, as a sequel to the results obtained overseas with the better New Zealand strains. Expanded production has been aided by the adoption of the header harvester to replace the clover huller in threshing the crop.

Climatic needs

White clover for seed production requires a climate that is dry during the latter part of December and January. In such conditions harvesting of the crop presents little difficulty, but for good crops reasonable rains are needed in autumn, winter and spring to promote the necessary growth for cutting. Soil types vary considerably on areas that have been harvested for seed. The medium silty loams of the Canterbury Plains are probably the most suitable for seed crops. On the lighter soils good crops are obtained in seasons when crops on the heavier soils are ruined because of too much moisture. Yields of 100 to 150 lb. per acre have been obtained from land worth £5 per-acre. As white clover is included in almost all seed mixtures, and by management can frequently be made the dominant constituent, most areas in country not too broken or steep and with a favourable climate can be considered potential seed-producing land.

Of late some farmers have sown special paddocks in white clover alone for seed production, but this is by no means the general practice. In areas more suited to seed production there has developed a system of sowing a simple mixture of 20 to 25 lb. of perennial ryegrass and 3 to 4 lb. of white clover with the aim of harvesting both for seed in successive years. The pasture is so managed that in the first season perennial ryegrass is harvested. In the second harvest the area is managed to suit the clover, involving much heavier grazing in spring to keep the ryegrass in check and encourage the clover to take charge, which it usually does. Under this method two crops are harvested at their peaks of production.

Where seed production is the aim, seed is usually sown after a summer fallow, and this method has much to recommend it. In other cases it may be sown with a rape crop or broadcast on a wheat, oat or linseed crop. When the seed is sown with a crop the strike usually is poorer. For establishment either spring or early-autumn sowing is satisfactory.



White clover seed (highly magnified). Certified Government stock seed is produced under contract by the Department of Agriculture and is distributed for further multiplication

Fertiliser requirements

It has become very evident during the past 10 to 15 years that one essential for clover growth is the application of lime and phosphate.

If lime has not been applied previously, at least 1 ton per acre is required, either worked into the soil before the crop is sown or, if the area is autumn sown, applied when the clover has become established. A dressing of 1 to 1½ cwt. of superphosphate should be applied when the seed is sown.

Management of seed areas

The management of an area to be saved for seed aims at having the clover plants growing vigorously and with strong root development. The foliage growth is kept under control by grazing until the flower heads begin to appear, when the plants spend their energy in seed production rather than leaf production.

The ideal treatment is to control the growth in autumn by reasonably-close grazing. If some growth is made during winter, it can be fed on the rationing system—about an hour a day for either cattle or sheep. In spring the area should be grazed closely during the flush and kept reasonably short until about the middle to the end of October, or even into November in some seasons, depending on the situation. In general the area should be closed for a seed crop when the first flower heads begin to appear.

The soil type has some influence on the length of time for which the land can be grazed. Areas on good clover land with a good supply of moisture can be closed later than those on the light plains land. Land is better closed up too soon than too late; if growth becomes excessive, the area can be grazed again, but if it becomes dry and the area has been grazed closely, a reduced yield or no crop is likely. Cattle probably are better than sheep for the final grazing, as they are unlikely to graze too closely; if not managed carefully, sheep will spoil a potential crop by over-grazing. After the area has been closed for seed no other treatment is required until harvest.

Where irrigation is available the treatment is somewhat different, as water is on hand at all times. The area is closed later, and just before that water is applied; a further application is given if the weather is such that the plants show signs of wilting.

Ideal weather for harvesting is hot and dry without heavy winds to scatter the cut material. Rain is not welcome after the crop has been cut because usually it causes second growth.

The time to cut clover for seed is very difficult to gauge, as flowering takes place over a long period. The crop is cut when at least three quarters of the flower heads are ripe and mature seed can be rubbed out in the hand, with the balance of the flower heads ripening off and the seed beginning to change colour.

Methods of harvesting

In the past the crop was cut with a mower, the swath allowed to dry out, and a side rake or hay rake used to draw the crop into windrows. All this handling involved loss of seed, but now with practically all harvesting done with a header harvester the crop can be left until ripe, cut and threshed without any other handling.

The weather at the time of threshing is important, as attempting to thresh the crop when the material is clammy will cause serious losses. For ideal threshing conditions the heads should be brittle and a cloud of dust should issue from the back of the machine.

Yields of white clover vary greatly from field to field, district to district, and season to season. Yields as high as 400 lb. of machine-dressed seed per acre have been obtained, but yields of 100 lb. or more may be considered satisfactory.

The presence of bees is also a factor in white clover seed production. Where they are present in sufficient numbers and the weather is suitable, a good setting of seed can be expected. The white clover seed crop is very susceptible to frost injury, and a frost of 5° to 6° in late November can reduce the yield by half and may even spoil any prospect of a seed crop.

The material removed in the machine dressing of seed from white clover-dominant stands averages from 30 to 40% of the line, depending on the season and the age of the pasture. Ribgrass and dock seeds are two of the main impurities, and these are difficult to separate from white clover seed. Another impurity of some consequence is suckling clover (*Trifolium dubium*); as seed of this species is of almost the same size range as white clover seed, it is very difficult, if not impossible, to remove during dressing.

Maintenance of seed pastures

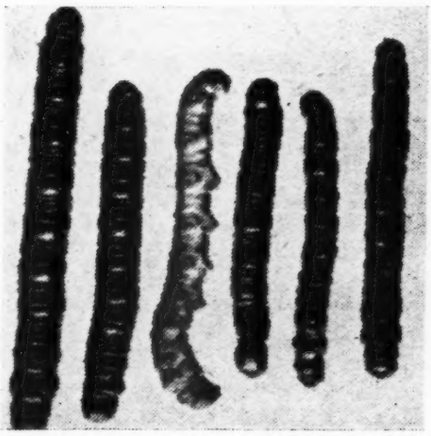
The maintenance of white clover areas for seed production is not easy, and it is not a good practice to take seed from an area year after year.

Continued seed production from one area ultimately affects the sward. Pastures that have been seeded for ryegrass or white clover or both deteriorate, but with good treatment in the way of fertiliser and lime, combined with careful stock management, on the better types of soils areas can be harvested for white clover seed and still maintain a first-class pasture.

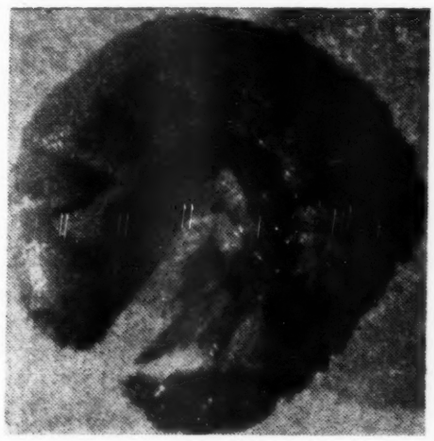
A factor which influences greatly the decision as to when to seed the area is the price; a yield of 30 lb. of machine-dressed seed may pay with seed at 4s. a lb., but is scarcely worth the loss of grazing with seed at 2s. a lb.

Strains of white clover

Investigations initiated by W. Davies and E. B. Levy disclosed that New Zealand, like other countries, had a wide range of white clover strains. The longest-lived and highest-producing strains were localised on the very fertile lands of Rangiora and Woodend in North Canterbury and of parts of the Heretaunga Plains in Hawke's Bay.



The porina caterpillar, which is responsible for a heavy death rate of the plants



The grass-grub. An application of lime and superphosphate have resulted in remarkable recovery on areas of white clover badly eaten by grass-grub

The export trade in white clover seed of 20 to 30 years ago recognised two main types, ' wild ' white and ' stubble ' white. The ' wild ' type in general was that from permanent grassland areas; the ' stubble ' type was largely the product of frequently-cultivated areas, as often as not the produce of volunteer growth following the harvest of a cereal. It was not surprising that such clover was of inferior strain or that confusion existed about the quality of New Zealand white clover and individual lines frequently were described wrongly.

Seed certification

The presence of these divergent strains provided a good field for the introduction of a scheme of seed certification.

Certification was applied first to seed from old pastures and then to natural strains of superior merit, but as a pedigree strain was selected from the best natural strains and seed supplies became available this formed the key material for the certification scheme. The scheme has made possible a much wider distribution of seed of better strain quality and, with direct benefit to production, has extended the sowing of white clover seed into areas where inferior volunteer strains grew previously and white clover seed was not sown because it ' came naturally.'

Seed is now certified in one of the following classes:

(1) *Certified Government Stock seed*, produced under contract by the Department of Agriculture. It is distributed for further multiplication.

(2) *Certified Pedigree seed*, from the second or subsequent harvest from an area sown with Certified Government Stock seed.

(3) *Certified Mother seed*, which may be taken in the first harvest from an area sown with Certified Government Stock seed or in the second or subsequent harvest from an area sown with Certified Pedigree seed.

(4) *Certified Permanent Pasture (Pedigree Strain) seed*, which is obtained in the first harvest season from areas sown with Certified Pedigree seed.

(5) *Certified Permanent Pasture seed:* Certification in this class is based on the fact that superior strains of white clover produce higher amounts of a cyanogenetic glucoside than do inferior strains.

Seed certified in all but the last class is entirely of pedigree strain.

Fungus and insect pests

White clover, like other pasture plants, has its insect pests. The porina grub (*Oxycanus* sp.) and the grass-grub (*Odontria Zealandica*) are responsible for a very heavy death rate of plants. In certain seasons, however, an application of lime and

A white clover crop maturing in the windrow

superphosphate and good autumn rains have resulted in remarkable recovery on an area badly eaten out by grass-grub.

The brown beetle, adult form of the grass-grub, is on the wing from November onward, depending on the locality, and finds the condition of the pasture just before harvesting ideal for laying its eggs. The grubs attack the roots of the plants about 2 in. below the ground, and unless good rains fall, the death rate in plants may be very high. As yet no satisfactory control measures have been devised.

The porina moth is on the wing between November and January. It also lays its eggs in pastures and thrives where growth has been allowed to get away. The juvenile form, or subterranean caterpillar, works at night, feeding on the leaves of the plant. During the day the caterpillar buries itself 4 to 6 in. below ground and only excessive moisture will bring it to the surface. The caterpillar can be controlled by the use of bran, molasses, and paris green or arsenate of lead made into a mash and top-dressed on to the pasture.

The clover case-bearer (*Coleophora spissicornis*) is a moth which lays its eggs when the clover is in flower. These are hatched out when the seed begins to ripen, and the grubs feed on the immature seed. So far this insect has not caused serious losses, but in certain seasons it is responsible for some damage to seed. No method has yet been devised for its control.

Growth of export trade

New Zealand requires about 750 tons of white clover seed a year for her own requirements, so that despite the quantity exported each year New Zealand's best market is still her own.

As far as records show, it would seem that New Zealand first began to export seed in any quantity about 1918 to 1920, and between 1922 and 1924 prices for white clover seed rose to 2s. 6d. and 3s. a lb. The seed exported at that time was drawn mainly from the Kaiapoi, Woodend and Rangiora districts, which subsequently were proven to have a superior type of white clover. This was responsible for giving New Zealand wild white clover a good reputation in the British market. The exports grew from a few tons in those years to about 1,400 tons in 1945-46, of which 916 tons were certified.

EXPORTS OF WHITE CLOVER SEEDS (tons)

	Certified	*Uncertified*	*Total exports*
1937 ..	71	54	125
1938 ..	84	88	172
1939 ..	69	97	166
1940 ..	198	130	328
1941 ..	332	352	684
1942 ..	292	225	517
1943 ..	240	140	380
1944 ..	838	526	1,364
1945 ..	684	220	904
1946 ..	916	528	1,444
1947 ..	737	501	1,238

Price fluctuations

The price of white clover seed has fluctuated considerably over the years. First the price of imported seed and later the price which could be obtained on the overseas market set the local market prices. In the 1920s the price rose and fell between 9d. and 3s., and in 1929-30, just before certification was introduced, it was 1s. a lb. As more certified seed became available and the demand grew, the price crept up until it was as high as 7s. 6d. for Certified Pedigree white clover. These prices have since declined and now range between 3s. 6d. and 4s. for Certified Mother seed and about 1s. less for uncertified seed.

Benefits of industry

Undoubtedly the greatest single contribution to improved methods of producing white clover seed has come from the use of the header harvester. Its introduction has lessened the work, reduced the risk and has made possible the harvesting of areas which, under older conditions of harvesting, would have been unprofitable.

The identification of superior strains of white clover under certification, the development of a pedigree strain from the best natural types available, and the expanded use of white clover seed in pasture mixtures in New Zealand have been prominent features associated with the development of the industry. Coupled with these have been the recognition given overseas to the better strains of New Zealand white clover and the place which these have won, particularly in the United Kingdom, leading to the present overseas export market.

Photos are reproduced from the New Zealand Journal of Agriculture.

Rice Cultivation in Morocco

Rice cultivation in Morocco in 1949 passed for the first time from the category of small experimentation to large-scale trials, in as much as something over 60 hectares were planted under the crop. Of these, 45 hectares are under cultivation between Souk El Arba Du Rharb and Port Lyautey.

According to the experts, an average yield of 50 quintals of paddy to the acre ought to be possible of attainment when the necessary installations and modifications in cultural conditions have been effected.

Accordingly, 6,000 hectares of rice field would provide sufficient rice to meet all the requirements of Morocco, which are estimated only at 12,000 tons annually.

Correction

The photograph illustrating male sterile flowers of tomatoes in Miss Ashton's article, 'Better Crops Through Hybrid Seed,' Vol. I, page 52, is wrongly acknowledged. It is reproduced from Bulletin 502 of the Agricultural Experiment Station, Pennsylvania State College.

Food Production and Unsaleable Surpluses

Problems before F.A.O.'s Annual Conference

TWO related but apparently conflicting issues—how to increase food production in some countries and how to prevent unmarketable surpluses from appearing in other countries—faced the annual Conference of the Food and Agriculture Organisation's 58 member governments in Washington, D.C., which began on November 21.

To deal with the first half of the problem, agricultural, nutrition, forestry and fishery technicians of the world reviewed F.A.O.'s plans for expanding production in the underdeveloped countries through technical assistance.

At the same time, leading economists of member countries discussed what F.A.O. Director-General N. E. Dodd described as the 'terrible paradox' which finds farmers in some lands threatened with ruin by plenty while millions in other lands are oppressed by hunger and poverty.

Specific proposals for bridging this gap between potential world demand and potential world supply of agricultural commodities came before the Conference. Though they differ widely in method and timing, they are interdependent, 'companion' measures.

One of the main proposals looks toward narrowing the gap between supply and demand in underdeveloped countries by expanding their ability to produce more. This has to do with F.A.O.'s part in the proposed expanded programme of technical assistance to undeveloped countries worked out by the United Nations and specialised agencies.

The Conference was asked to give official sanction to F.A.O.'s participation in the technical assistance programme and, in addition, to give detailed consideration to the views of member governments on methods for conducting such a programme and on the urgent needs for action.

A second proposal is designed to deal with unmarketable surpluses which may exist now, or threaten to exist soon, in countries which produce certain important agricultural commodities beyond the needs of their own people. This proposal, developed by an international committee of experts brought together by the Director-General, is that an International Commodity Clearing House be created within F.A.O.

As proposed in broad outline, the Clearing House would be like a public corporation, with a substantial capital, empowered to buy, for resale, agricultural surpluses occurring in member countries. Resales would be made to importing countries either in their own currencies at the regular 'going' price, or at a special low price in a currency acceptable to the supplying country. In all cases I.C.C.H. would satisfy itself that such sales represented additional trade and were not in substitution for ordinary commercial transactions.

The function of the Clearing House would be to give producing countries assurance of markets and thus to keep production at high levels to meet the world's need until longer-term measures—such as those developed under the technical assistance programme—favouring a return to multilateral trade and currency convertibility can make themselves felt.

Americans Assist British Guiana to Increase its Production of Rice

Two American agricultural experts with experience in modern methods of rice cultivation and milling have arrived in British Guiana to help the local Government in its efforts to increase the production of rice.

The two experts are Mr. Henry M. Beachell, associate agronomist in rice production and breeding, U.S. Bureau of Plant Industry, Texas College Station, Beaumont, Texas, and Mr. O. B. Brown, a farm management specialist with the Arkansas Agricultural Extension Service. They will spend three months in British Guiana.

The probject was arranged under E.C.A.'s Technical Assistance Programme at the request of the British Government. While in British Guiana, the two Americans will assist in the preparation of a report on the local rice industry and recommend measures that may improve rice production in the territory. The report will include recommendations concerning the areas in British Guiana where rice cultivation can be most economically extended, the most efficient methods for developing new rice farms, the reorganisation of milling facilities and the use of mechanical equipment for rice cultivation.

In their study of rice production the two Americans will take account of the Government's plan for draining and irrigating new areas for rice farms. Present plans call for the irrigation of about 82,500 acres of land along the British Guiana coast.

Mr. Beachell has been a member of the Division of Cereal Crops and Diseases at the Department of Agriculture's rice substation No. 4 at Beaumont since 1931. He is a graduate of the University of Nebraska and received a Master's degree from Kansas State College.

Mr. Brown received two degrees from the University of Illinois. He served as an officer in the U.S. Marine Corps from 1936 to 1943 and has been connected with the Arkansas Agricultural Extension Service since 1946.—*U.S.I.S.*

Dutch Fertiliser Output

The output of nitrogen fertiliser by the Dutch state mines will be doubled before long, after the inauguration of the new plant at Lutterade in Limburg province.

Holland has three major nitrogen fertiliser producers, the Mekog at Igmuiden, the state mines and a company at Sluiskil in Zeeland province.

Holland's annual requirements total 125,000 tons and annual output of the state mines so far totalled only 60,000 tons.

Important parts of the new plant have been delivered by British firms. Its construction required 16,000 cu. m. of concrete, 2,200 tons of steel and iron and 3,500 cu. m. of glass.

1949-50 World Potato Production Back to War-time Levels

THE United States Department of Agriculture reports that world potato production in the 1949-50 season is estimated at 8 billion* bushels, approximately the same as the 1940-44 war-time average, but about 9% below the 1948-49 crop of 8.8 billion bushels and 4% below the pre-war 1935-39 average of 8.3 billion bushels.

The 1949-50 estimate is based on preliminary reports from most potato-producing countries in the northern hemisphere and on forecasts of crops yet unharvested in the southern hemisphere, which produces not more than 2% of the world's crop. The bulk of the world's crop, about 55%, is grown in Europe, excluding the U.S.S.R. The U.S.S.R. alone, including Soviet areas in Asia, produced in 1949 2.8 billion bushels or 35% of the world total.

The 1949 crop of 8 billion bushels, while below 1948 and below pre-war, is just about at the estimated war-time 1940-44 average. This lower level does not reflect a world-wide decline of potato acreage. Instead it reflects a lower-than-average yield per acre, particularly in Europe.

World potato acreage in 1949-50 of 53.3 million acres is 6% above the pre-war average of 50.5 million. It is only slightly above the 52.2 million acres of last year and 4% above the war-time (1940-44) average of 51.4 million acres.

The estimated world yield in 1949 dropped to 150 bushels per acre, compared with 164 bushels pre-war, 157 bushels the war-time average and 168 bushels last year. The low yield this year was due to unfavourable weather in most of the large potato-producing countries of Europe. The high yield last year was due to almost universally good weather for potato crops.

With world population up 10%, the supply of potatoes per capita is below pre-war. This likely will result in fewer potatoes being used for feed and industrial purposes rather than in any significant decline of potatoes used for food.

In certain northern and western European countries, taken as a whole, including the United Kingdom, Ireland, the Netherlands, Belgium, Luxemburg, France, Western Germany, Denmark, Norway and Sweden, production is 3% below pre-war, due largely to a severe reduction in France. The total reduction in these countries is 27% below the high of last year, due partly to adverse weather in the growing season and partly to a decrease of acreage. The decrease of acreage reflects both governmental and grower reaction to the unusually large potato crop of 1948 (for details see *Foreign Crops and Markets*, May 16, 1949).

In certain countries of eastern Europe, notably Poland and Czechoslovakia, production has been maintained or increased measurably above last year, but it is still 24% below pre-war. In the U.S.S.R. production has decreased slightly below last year, but is about 3% above pre-war. Acreage, on the other hand, has increased measurably in nearly all of these countries above last year, and it is above pre-war in Poland and the U.S.S.R. Acreage in the latter country has recently been reported at almost 1 million acres above the 22.4 million acres of last year and 3.2 million above pre-war.

Yields have declined in all of Europe. In the U.S.S.R. they have declined from 134 bushels per acre pre-war to 133 during the war (average 1940-44) to 128 last year and to 120 this year. In Europe, excluding the U.S.S.R., they have declined from 200 bushels pre-war to 187 during the war to 180 this year. Last year yields in Europe were 210 bushels per acre. The low yields this year were the result of excessive drought in western Europe and of excessive rain during the growing season in U.S.S.R.

The United States and Canada (including Newfoundland and Labrador) produced 98% of the total North American crop in 1949, but only 6% of the world crop. The North American crop of 473 million bushels in 1949 was 14% below the large crop of 549 million bushels last year, but still 11% above the pre-war production of 427 million bushels. Considering the increase of population this would mean that the 1949 crop in America is just about at normal per capita levels.

Contrary to the situation in Europe, however, where potato acreage has been maintained at pre-war levels, acreage in America has declined by 30% from pre-war. The North American acreage estimated at 2.6 million acres in 1949 is 7% less than last year, 27% less than the war-time (1940-44) average and 30% less than the 3.6 million acres average of pre-war. Production has increased on the North American continent solely because of higher yields per acre. The average 1949 yield was 185 bushels, compared to 199 in 1948, 135 war-time (1940-44) average and 117 pre-war.

Increases of production have occurred in the smaller producing areas of Asia, Africa, South America and Oceania, but these increases are significant only in the areas themselves and not as they affect world totals.

*A billion in America is equal to 1,000 million.

Research in Vegetable Production

A STATION for research in vegetable production in Great Britain has now been established under a governing body constituted as a company limited by guarantee and without a share capital, with the title 'The British Society for the Promotion of Vegetable Research.'

The members of the governing body—23 in number—include nominees of the agricultural departments of Great Britain, the Department of Scientific and Industrial Research, various learned societies, universities and institutions concerned with horticulture, vegetable producers large and small and of trade interests. The chairman of the Society is Prof. F. T. Brooks, M.A., of Cambridge University, and the director of the research station is Dr. James Philp.

A site has now been chosen at Wellesbourne in Warwickshire for the headquarters station. It consists of 280 acres of deep sandy loam over gravel or keuper clay; the land is being purchased by the Ministry of Agriculture and will be leased to the Society.

The Ministry is also leasing to the Society 150 acres of land at Paglesham in Essex for a sub-station to be used for the multiplication of stocks of seed of vegetables. A second sub-station is the former horticultural research station at Cambridge, which has been taken over from Cambridge University.

The Society will work in close co-operation with existing research institutions. For the funds for its work, it will at the outset depend on grants from the Ministry of Agriculture, and will be guided by the scientific advice of the Agricultural Research Council, who will have the scientific oversight of the work and staff.

FARM MACHINERY IN CANADA

U.K. Mission satisfied that there is scope for British-made machinery

DURING 1949 a mission headed by Capt. E. N. Griffith, President of the Agricultural Engineers Association, visited Canada at the invitation of the Canadian Federation of Agriculture with the object of studying farming methods at first hand and ascertaining how far British machinery manufacturers would be able to supply the requirements of Canadian farmers.

The report of this mission has recently been published.* It contains much valuable information concerning Canadian farming. The mission found Canadian farmers perturbed by the dollar exchange problem and anxious to contribute to its solution, but they were ill-informed about the extent and the high standards of the British agricultural machinery industry.

Canada imports annually £35 millions worth of agricultural machinery, but less than 1% of this comes from the United Kingdom and the remainder is derived almost exclusively from the U.S.A. The mission concluded that with a few important exceptions there are no machines in use on Canadian farms today which could not be supplied from the United Kingdom sources, of a quality at least as high as those of North American competitors and at prices competitive with those of American firms. The report was written before the pound was devalued and this occurrence should presumably greatly improve the competitive power of British machinery.

Mechanised farming in Canada

So far as concerns tractors, Canada with five times as much crop land as Britain, has at present roughly the same total number of tractors; this is explained by the fact that over most of the great prairie area each tractor deals on the average with a much larger acreage. Tractor sales have steadily increased since the war; in 1948 44,000 were sold and this represented an increase of 34% on the figures for the previous year. It is evident, however, that the sellers market is coming to an end and that Canadian farmers will shortly be able to get all the tractors that they want without restriction of choice. It is, however, considered that the number of tractors will continue to increase for many years to come. There is scope for much more mechanisation in the east while the newer farming land in the prairies and north of them will be developed along lines which will call for more equipment.

Types of tractor wanted

It is evident that although there is a good market for large tractors, both in the east and the west, the most important demand is for the medium-powered group. It is suggested that in the future most ordinary farms will need a tractor of at least two-plough capacity, but the few will want those of more than three-plough capacity.

Wheeled tractors are on the whole preferred and track-layer sales have been almost negligible of recent years. It is anticipated that interest will develop in small track-layers for work in orchards and plantations, particularly in British Columbia, but the potential market is small. Half-tracks are at present unknown and might interest large-scale farmers in the wheat belt.

The small market-garden tractors of about 1½ horse-power are used throughout Canada on small-holdings round cities, and it seems probable that the demand for them will spread to larger farms. Rotary tillers are fairly common in market-gardens and should be useful where excessive soil pulverisation is to be avoided.

Hydraulically operated directly-attached implements are steadily gaining popularity in Canada, especially in Quebec, Ontario, British Columbia and parts of the prairie provinces.

Ploughs and cultivators

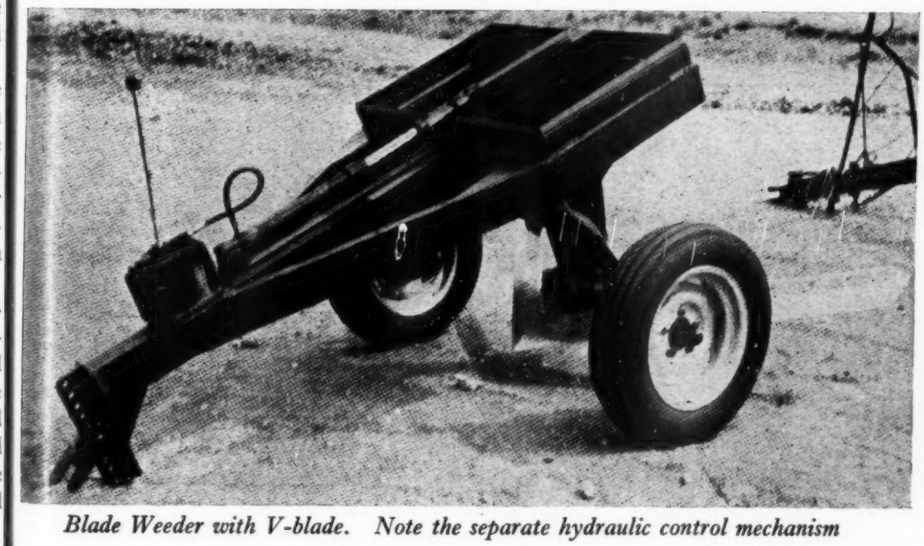
In eastern Canada the moulboard plough is the basic tillage implement but, because of the depth to which the land is frozen in winter, deep cultivation is not practised and ploughing rarely goes below 7 in.; the greater certainty of dry summers also makes weed control simpler.

Ridged and springtime cultivators and disc harrows are used in much the same proportion as in England; the normal range include heavy and light harrows and many springtooth harrows. Rollers are less in evidence than would be expected having regard to the loosening of the ground as a result of frost in winter.

On the prairie different methods prevail since the main requirements here are conservation of moisture and prevention of soil drift. In very dry areas moulboard ploughs have been completely superseded by disc ploughs.

The key to the system is the fallow, operated every second or third year for the conservation of moisture and for weed control; the object of ploughing is to undercut the soil so as to destroy weeds, while stubble and trash remain sufficiently pegged down. Typical examples of machines in use are what are called the discer and the blade-weeder. The first is a wide, light, one-way disc plough with up to six gangs of seven discs each, normally about 18 in. diameter with 2 in. concavity which can be slightly angled to cut a wider or narrower swath, with the addition of self-lifts which enable the disc gangs to be raised without raising the frame. Discers are usually fitted with a seed box so that the machinery becomes a seeder as well.

The blade-weeder may be a single-width blade either straight or 'V'-shaped or two 'V' blades side by side. The blade slopes downwards and is drawn



Blade Weeder with V-blade. Note the separate hydraulic control mechanism

**Report of the British Agricultural Machinery Mission to Canada, 1949, pp. 59 + iv. His Majesty's Stationery Office, 1949, price 2s.*

along two or three inches below the surface so that it cuts off stubble and weeds without otherwise disturbing them.

Seeding attachments to disc ploughs are used almost solely with cereal grains; for grass seeding in the prairie areas, standard seed drills with internal roller force-feed are used widely, but in some places special grass seed attachments are common. In sugar beet areas the most popular type of drill is the trailing six-row beet and bean drill with fertiliser placement equipment.

Fertilisers are used only on a small scale in the wheat belt because where moisture is the limiting factor and the level of soil nutrients high, fertilisers may be uneconomic, although in some parts satisfactory increases may follow the use of concentrated compound fertiliser containing ammonium phosphate with 11% nitrogen and 48% phosphoric acid.

In the eastern provinces and in parts of British Columbia machines for broadcasting fertilisers are commonly used, but combined grain and fertiliser drills are preferred for cereal crops. Farmyard manure is almost invariably distributed by mechanical spreaders, while the use of tractor-mounted hydraulically operated manure loaders and stackers is generally accepted throughout Canada.

Planters and transplanters

Potato growing is extending in Canada, but planting on a large part of the acreage is still done by hand; elsewhere the machine most commonly used is an automatic-picker-type planter covering two to four rows at a time and fitted with a fertiliser attachment.

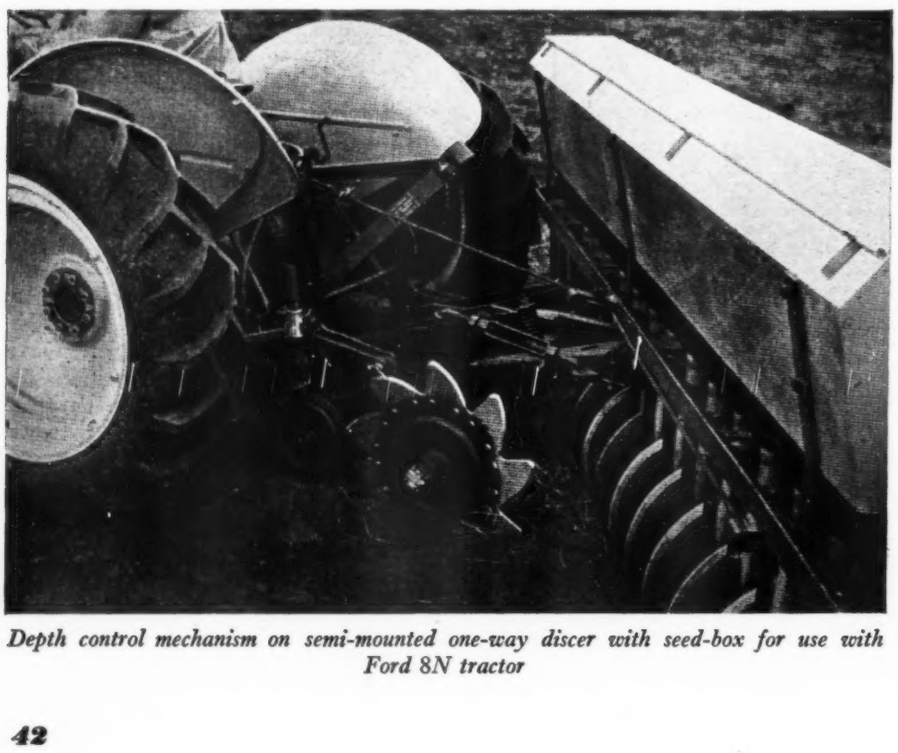
Transplanters are little used in Canada and there should be a market for an efficient mechanical type wherever transplanted crops are grown. Hay-making machinery differs somewhat from standard English types; side-delivery rakes are a standard item, but the combined swath-turner and side rake is almost unknown. The usual side-delivery rake is carried in an inclined frame with a flexible mounting which enables it to adjust itself to the ground.

A few factory-scale grass driers are in operation and in some districts some demand exists for smaller farm driers. Silage is made on most medium and large dairy farms, the usual method of ensiling maize being to cut it by hand or by maize binder, load it by hand and to chop with a stationery cutter-blower at the silo. In Toronto many new silos are being erected, mostly of concrete; trench or pit silos are used in some districts, but owing to winter snow they must be near buildings and well protected.

Harvesting machinery

Combines are the commonest harvesting machine on the prairies, swathers or windrowers now being regular farming equipment on the larger farms and probably 90% of all grain harvested is first windrowed for protection from damage by wind and hail. The use of a swather enables one combine to deal with a greater acreage, cutting may be done early and may save a crop infected with saw flies, grasshopper damage is reduced and threshing and weeding are also facilitated.

Mechanised lifting of potatoes has not made much advance in Canada as a whole, while only about 10% of the sugar beet crop is lifted mechanically.



Depth control mechanism on semi-mounted one-way discer with seed-box for use with Ford 8N tractor

Pest and weed control

Spraying for weed control has rapidly extended, although 2-4D has only been recently introduced. Spraying equipment of the low-volume type similar to that used in the United Kingdom is used on a wide scale.

Spraying against blight, aphis and Colorado beetle is usual in the main potato-growing areas; spraying with medium-pressure machines is considered to give better results than dusting. Orchard spraying in fruit-growing areas is usually carried out by portable high-pressure sprayers pulled by a tractor working at pressures around 400 to 600 p.s.i.

Irrigation

Large-scale irrigation and water conservation schemes are important features in western Canada. Many projects are in progress, the development of which will lead to large extensions in the area cultivated and heavy demands for irrigation equipment. In the prairies, water is preserved by pits placed to catch the run-off of the melting snow. In distributing water many farmers are beginning to use overhead sprinklers.

The recommendations made by the commission include the appointment of an industry representative to examine thoroughly the prospects of the market, to appoint distributors and to give all possible assistance in pushing British farm machinery.

The setting up of a spare parts organisation to relieve the distributor and dealer from holding large stocks of spares and yet to make it as easy to get spares of British machinery as for Canadian and American machinery is also recommended.

Efforts should be made to publicise Britain's farm equipment as widely as possible by (*a*) sending to universities machinery for demonstration and instruction during the winter months; (*b*) by publishing articles about British machinery in farming journals and through radio talks, etc.; (*c*) by the interchange of students between British and Canadian universities and by encouraging exchange of visits by Canadian Junior Farmers' and English Young Farmers' clubs; (*d*) by exhibiting selections of British machines at important shows, prairie fairs, ploughing matches, etc.

Conclusion

The report concludes that Canada will remain a difficult market for British farm machinery, but a substantial increase in present sales could be achieved provided price and marketing problems are solved.

Care of Machines in Winter

THE frost and damp air of winter can bring quick deterioration both to machines in use and to machines stored away until their season of work comes round in the spring.

Combine harvesters and other harvest machines should not be left untreated and unattended during the winter months. They should be put away carefully and inspected from time to time. Driving belts should be taken off; if they are left on they stretch and lose their shape. The part of a V-belt resting in the groove of a pulley is compressed and will in time take on a permanent set, and thus become narrower than the remainder of the belt. A belt with some parts narrower than others runs unevenly and bounces; its life is shortened and so is the life of the bearings on the shafts which are driven.

If there are any petrol or other internal combustion engines on the machines they should be weather-proofed inside and out, and batteries and other accessories liable to deteriorate quickly should be taken off and treated separately.

Any water-cooled engines that are being stored must have their radiators and water-jackets emptied most carefully lest the water should freeze and, in expanding, burst cylinder blocks and radiators. This water-freezing hazard is, of course, nearly as serious in the machines being used throughout the winter as in those being stored. In stationary engines working in winter this also applies to the cooling water, and in tractors not only to the cooling water but also to water used as ballast in the tyres.

Anti-freeze mixtures are the best safeguard for the radiators of petrol tractors and for the tubes of pneumatic tyres. Calcium chloride solutions are perfectly suitable in the rubber tubes of tyres, but they would corrode the metal of the cylinder and radiator of an engine, so alcohol or other non-corrosive fluids must be employed in the cooling water. Even for tyres, calcium chloride in its commercial form sometimes gives too acid a solution and this may affect valve parts, so it is well to stir in 1lb. of slaked lime with every 100 lb. of calcium chloride used.

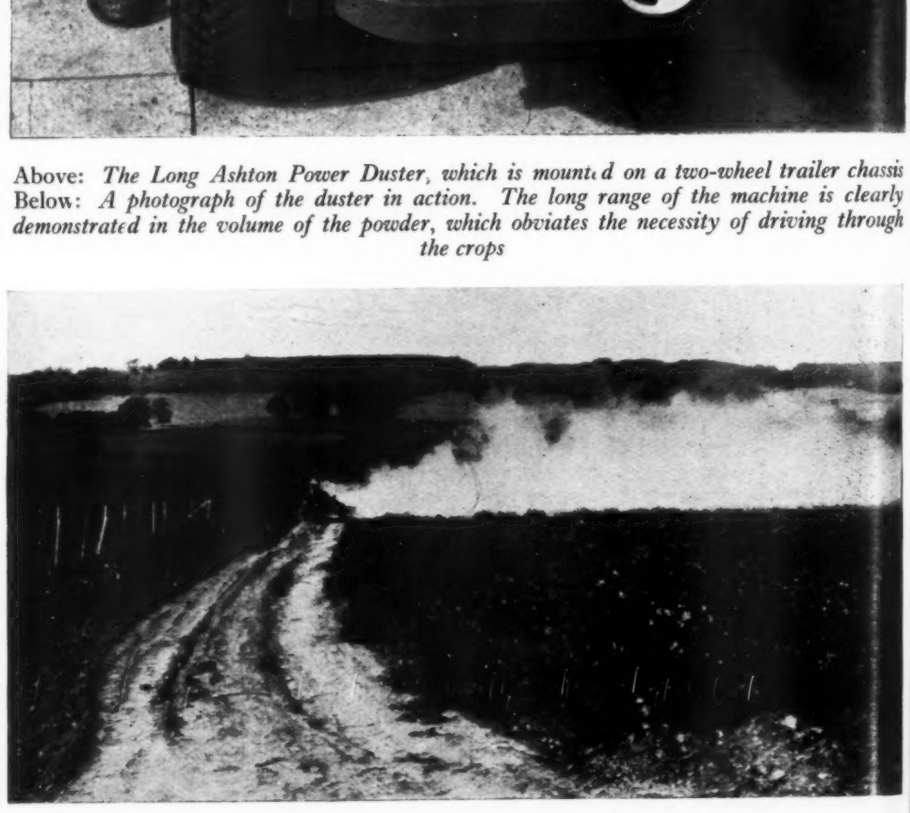
The use of anti-freeze solutions is usually too expensive in vaporising oil engines, because the fluid is apt to be lost by boiling out of the overflow pipe, since engines of this sort have to be run hot if the tractor is to be efficient. So the water must be let out of the radiator on any evening when there is the slightest risk of frost.

Fertiliser distributors and combine drills must be watched very closely when they have been used on damp days, because any powder left in the machine is likely to cake into a hard lump. At the end of the day the machine should be run until the hopper is quite empty and then the distributing mechanism should be cleaned with a stiff brush. When a distributor has to be left in the open all night it should be covered with a waterproof sheet or plenty of empty bags, but whenever possible the machine should be brought under cover and the metal parts that have been in contact with the powder brushed clean and covered with grease or anti-rust compound.

A New British Power Duster

Crop protection by insecticides and fungicides is more efficiently secured by spraying than dusting. For example, Dr. H. Martin of Long Ashton Research Station has recently stated that six to eight dustings are needed to protect potatoes from blight to the degree obtained by two sprayings. Many important cases occur, however, where spraying is difficult or impracticable and where dusting would be much easier. Spraying requires either a piped water supply on the farm or plantation, or it must be conducted with heavy water-carrying machinery as well as with the actual spraying equipment. Also, with certain climatic conditions, the water supply may be insufficient at a time when pests are attacking crops severely. The development of new and better dust-applying machines is therefore important.

A new power duster has recently been produced in England. It has been designed by Dr. Kearns and N. G. Morgan of Long Ashton and the prototype and subsequent machines have been built by Messrs. Welding Industries Ltd., of Bristol. The performance of the prototype machine was tested at Long Ashton for several months before production began. The power duster has already been used in Zanzibar to protect the clove crop from the ' sudden death ' disease and in Nigeria for locust control. It is claimed that applications from 1½ lb. per acre upwards can be distributed.



Above: *The Long Ashton Power Duster, which is mounted on a two-wheel trailer chassis*
Below: *A photograph of the duster in action. The long range of the machine is clearly demonstrated in the volume of the powder, which obviates the necessity of driving through the crops*

Method of operation

The duster is self-motored and mounted on a two-wheeled trailer chassis. It has an automatic sack lift for tipping the dust into the hopper of 2-cwt. capacity. The dust falls on a feed spider which agitates it so that it flows through the feed gap at a uniform and adjustable rate. From the feed gap the dust is sucked on to the blades of a paddle fan, and it is thus rapidly pulverised and delivered at high speed to the fan discharge port. The fan has a speed of 2,000 r.p.m. and a capacity of 2,000 cu. ft. of free air per minute.

A swivel trunk is fixed to the discharge port, and discharge nozzles allowing various directions of delivery can be quickly fitted to this trunk. The trunk itself has a vertical adjustment through 60°. Upward, side and rearward directions of power dusting can be obtained and the angles of these deliveries are widely adjustable.

This new British machine, known as the Long Ashton Power Duster, is robust in construction and offers a wide range of dust application performance. It is already attracting interest in tropical countries, but it may well suit British farm conditions, particularly for applying some of the modern selective weed-killers in dust form.

Left: *The Mark VF Diesel crawler tractor hauling a Fisher Humphries ' Moracre ' plough set at a depth of 13 in.* Right: *The tractor with hydraulically-operated angledozer and bulldozer attachments*

Demonstration of New Tractor Equipment

An interesting demonstration of hydraulic equipment built for use on the Fordson Major tractor was given at Reading recently by ' Foreloda ' Equipment Co. Ltd.

The parent equipment is quickly fitted and no modification to the tractor is necessary. The range of implements supplied with the unit are fitted or removed in a matter of seconds; this feature is indeed of great importance in saving time and labour.

The first implement demonstrated was a general-purpose bucket with 10½ cu. ft. capacity to lift 10 cwt. to a height of 9 ft. Then followed a scraper blade similar in appearance to a bulldozer of about 6 ft. in width with a trip action. A jib extension which converted the tractor into a crane was a useful implement and was demonstrated lifting a tree trunk. In order to draw attention to a safety valve device fitted to avoid strain in the tractor, four men sat on the tree trunk and the jib automatically stopped; when the men moved away the jib raised the trunk.

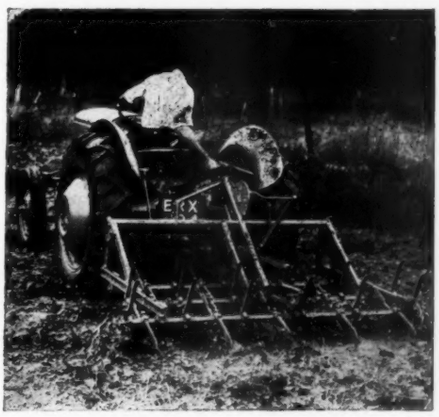
Other implements included a manure fork, stacker frame for bricks or crates, and a working and loading platform which raised loads to 12 ft.

Economy of cost and speed of manipulation make this compact unit an important addition to farm machinery.

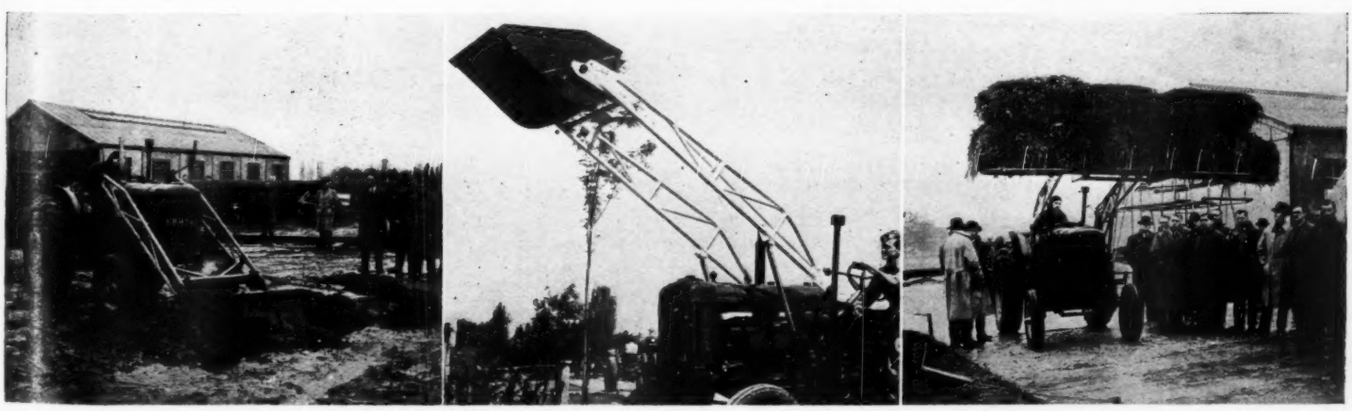
New Attachments for British Fowler Mark VF

The well-known British Fowler Mark VF crawler tractor has now been fitted with hydraulically-operated angledozer and bulldozer attachments. The unit has been designed for medium duties and when employed on such work is reported to have proved efficient and economical; the conversion of the tractor from this form to normal duties is simple and rapid.

In the above photographs the tractor is seen in operation.



Above: *The self-cleaning Wilder ' Pitch-pole ' which has twice been awarded the silver medal of the Royal Agricultural Society of England. It is a rigid-tine machine designed to be fitted to the hydraulic lift of the Fordson and Ferguson tractor*



Left: *The 'Foreloda ' scraper blade filling in a trench.* Centre: *The general-purpose bucket which lifts from the ground to a height of 9 ft.* Right: *A loading platform for hay which raises loads to 12 ft.*

WORLD CROP REPORTS

World Cotton Crop for 1949–50

World production in 1949-50 is expected to exceed world consumption by approximately 2.5 million bales. Most of the increase in production is likely to be reflected in larger stocks in the United States at the end of the current season. The textile industry in India easily can absorb the production increase of nearly 500,000 bales in that country, and most of the surplus from Mexico's record crop has already been sold for export. Other increases are relatively small and are in countries where market conditions and exchange controls practically assure easy disposal of any surplus production.

The 1949-50 crop in **Mexico,** now estimated at 815,000 bales, is by far the largest on record and approximately double the 1940-44 average. Acreage was increased from 1,050,000 acres in 1948 to 1,334,000 in 1949. One of the principal factors responsible for the sharp upward trend in acreage since 1946 is the opening of new irrigation systems in or near the principal areas already producing cotton. Devaluation of the peso on July 22, 1948, from the equivalent of 20.6 cents to 14.4 cents enhanced cotton prices in terms of Mexican currency and provided a strong incentive to increase production in 1949. A further stimulus to production was the liquidation in 1947-48 of all surplus stocks accumulated during the war period and the initiation of improvements in the ginning and handling of cotton that made the Mexican staple more readily acceptable in foreign markets.

In the **United States** the estimated 1949 crop of 15,446,000 bales is 560,000 bales or 3.8% larger than the 1948 crop of 14,868,000 bales and is the seventh largest on record. The acreage increase from 22,768,000 to 25,907,000 acres amounted to 13.8%. Yields in 1949, however, over the Cotton Belt as a whole are expected to average only 286.2 lb. per acre compared with 313.1 in 1948. Acreage increases were reported from all cotton-producing states, but yields and production were reduced in all the central and eastern states by excessive rain and unusually heavy boll weevil damage. Favourable weather and sharp increases in acreage and yield per acre in the western states, especially Texas and California, resulted in production increases that exceeded the losses in the central and eastern cotton states.

Production in southern and south-eastern **Europe** increased again in 1949 to a total of about 207,000 bales, compared with 166,000 in 1948 and a pre-war average of 147,000 bales. Most of the increase was accounted for by **Greece** and **Yugoslavia.**

Reports from the **Soviet Union** are only fragmentary but indicate that the 1949 crop may have been around 200,000 bales larger than a revised estimate of 2,600,000 for 1948.

Early reports on the 1949 crop in **Turkey** indicate probable production at 367,000 bales, which is 59,000 bales higher than last year's above-average crop.

Production estimates for **China** are highly speculative in view of the difficulties involved in collecting data, but such data as are available indicate a 1949 crop of around 1,860,000 bales, or about 255,000 bales below the estimate for 1948.

Weather conditions were more favourable in **India** during 1949 and a crop of about 2.4 million bales is expected, compared with the small crop of about 1,960,000 bales in 1948-49. Acreage is reported to be considerably larger than the 11,055,000 acres estimated for 1948-49 and yields are expected to be higher than those of a year ago.

Growing conditions in **Pakistan** have been favourable so far this year, but acreage is about the same as the 2,715,000 acres reported for 1948-49. On this basis a crop of around 900,000 bales is expected in 1949-50, or about 75,000 bales more than that of a year ago.

The 1949 crop of 101,000 bales in **Korea** is 30 to 40% larger than those of the three previous years, but is little more than half of the pre-war and war-time averages. The goal for 1949 was set at 144,000 bales. Pressure for greater production of food crops has limited the cultivation of cotton in post-war years.

The **Argentine** cotton crop now being planted is not expected to vary much from the 446,000 bales harvested in 1948-49 from 1,235,000 acres. A shortage of labour is still the principal factor retarding efforts to increase cotton production in Argentina.

The 1949-50 crop in **Brazil** cannot be estimated accurately at the moment, but severe drought conditions reported at the end of 1949 indicate acreage may not equal that of 1948-49 and production can hardly exceed the 1948-49 crop of 1,500,000 bales unless weather conditions are exceptionally favourable.

Peru's 1949-50 crop is expected to return to the more normal (post-war) level of around 300,000 bales, compared with the 1948-49 low crop of 264,000 bales.

No information is available from **Paraguay** to indicate any substantial variation from the previous crop of 50,000 bales.

Egypt's 1949 cotton crop is now estimated officially at 1,616,000 bales (500 lb. gross) from 1,754,000 acres, indicating a decrease of 12% in production from an acrea increased by 17%.

Planting of the 1949-50 crop in **Uganda** was delayed for several weeks by drought. The total acreage planted is reported to be about the same as the 1,551,000 acres harvested in 1948-49, but due to late planting, yields may be considerably lower than in the previous year. A crop of only 250,000 to 275,000 bales is expected, compared with a near record of 317,000 in 1948-49.

No information is available from the **Anglo-Egyptian Sudan** and other cotton areas on the east coast of Africa, but drought at planting time was rather general and no appreciable increases, if any, are expected.

The 1949-50 crop in **French West Africa** is estimated at 35,000 bales, an increase of 12,000 over that in 1948-49. In **Angola** a crop of 25,000 bales is expected, representing an increase of 5,000 bales. It may be presumed that production in the **Belgian Congo** and **French Equatorial Africa** will be equal to, or larger than, the 1948-49 crops of 220,000 and 110,000 bales respectively.

Record Soya Bean Harvest in Canada

Canada produced a record soya bean crop of 2 million bushels in 1949, according to the second official estimate. The 1948 harvest amounted to 1.8 million bushels, and the pre-war average 207,000.

Growers have been encouraged to increase soya bean acreage in order to minimise Canada's reliance on imported oils. Soya beans are one of the few sources of edible oils suitable for margarine manufacture that can be grown profitably in Canada.

Argentine Rice Acreage Up

Trade sources expect an increase of 10 to 20% over last season in Argentina's rice acreage for 1949-50. This would be about 148,000 acres, the largest planting ever reported. If yields are near the 1944-48 average, the new crop may reach around 7,462,000 bushels of rough rice. This would be the second largest crop on record, exceeded only in 1943-44 when 8,690,420 bushels were harvested from 138,000 acres as the result of extraordinary yields.